

# Archives of Neurology and Psychiatry

VOLUME 55

JUNE 1946

NUMBER 6

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## OCCURRENCE OF MULTIPLE NEURITIS IN CASES OF CUTANEOUS DIPHTHERIA

MAJOR HERBERT S. GASKILL

AND

CAPTAIN MILTON KORB †

MEDICAL CORPS, ARMY OF THE UNITED STATES

CUTANEOUS diphtheria is rarely seen in the temperate zone, but it is a common cause of disability among soldiers serving in the tropics.<sup>1</sup> Abrasions, blisters, insect bites, gunshot wounds and dermatophytic fissures, to mention only a few of the common lesions of the skin, are frequently secondarily infected with virulent *Corynebacterium diphtheriae*. These infections develop into the chronic ulcers of cutaneous diphtheria, which have been called variously desert sores, septic sores, barcoo rot and veldt sores.

In the fighting around Myitkyina during the North Burma campaign a small epidemic of cutaneous diphtheria occurred among American soldiers. One hundred and forty cases of this condition were studied at the Twentieth General Hospital: In 61, or 43 per cent, of this group multiple neuritis developed as a complication. The purpose of this report is to analyze and record the observations in these cases of neuritis. Articles covering the dermatologic, bacteriologic and cardiac aspects of this series are to be reported by Livingood<sup>2</sup> and Kay<sup>3</sup> and their associates.

These 140 cases of cutaneous diphtheria were divided into two groups—A and B. In group A, consisting of 109 cases, the patients were admitted directly to this hospital shortly after their diphtheritic

† Captain Korb died Dec. 29, 1945.

1. (a) Wilson, S. A. K.: *Neurology*, Baltimore, Williams & Wilkins Company, 1940. (b) Walshe, F. M. R.: On the Pathogenesis of Diphtheritic Paralysis, *Quart. J. Med.* **12**:14-37 (Oct.) 1918-1919; (c) Forms of Peripheral Neuritis Among Troops Serving with the Egyptian Expeditionary Force, 1915-1919, *Brain* **43**:74-85 (May) 1920. (d) Norris, R. F.; Kern, R. A.; Schenck, H. P., and Silcox, L. E.: Diphtheria in Tropics: Report of Eighteen Cases on a United States Naval Hospital Ship, *U. S. Nav. M. Bull.* **42**:518-524 (March) 1944.

2. Livingood, C. S.; Forrester, J. S., and Perry, D.: Cutaneous Diphtheria: Report of 140 Cases, to be published.

3. Kay, C. F., and Livingood, C. S.: Myocardial Complications of Cutaneous Diphtheria, *Am. Heart J.*, to be published.

ulcers had developed. In the remaining 31 cases, which comprised the B group, the patients either were referred from a forward hospital because their lesions were unusually slow to heal or sought admission because multiple neuritis developed after they had been discharged from their original hospital as recovered. The number of cases of multiple neuritis which developed in the two groups is seen in table 1.

The incidence of multiple neuritis as a complication cannot be accurately estimated from these figures, since many factors distort their validity, e. g., the relatively small number of cases, factors of selection which determined the hospitalization of patients and, particularly, the fact that there is no accurate estimate of the total number of cases of cutaneous diphtheria. The figures for the A group probably are more nearly representative of the incidence of the neuritic complication, although they, too, are probably weighted, since only the patients who were most severely ill were evacuated to a general hospital.

All the patients with neuritis included in this study were treated as hospital patients. When the neuritis began while the patient

TABLE 1.—Incidence of Multiple Neuritis in Cases of Cutaneous Diphtheria

	Number of Cases of Cutaneous Diphtheria	Incidence of Neuritis
Group A.....	109	37 (33.9%)
Group B.....	31	24 (77.4%)
Total.....	140	61 (43.5%)

was still in the hospital, he was transferred to the neurologic ward. In those instances in which the neuritis became symptomatic after the patient's discharge he was admitted directly to the neurologic service. The patient's progress was evaluated at weekly intervals by a complete neurologic examination. Routine studies of the blood included determination of the sedimentation rate, a blood count and the Wassermann test. Examinations of the spinal fluid were made at frequent intervals.

All the patients were given the Schick test, but the data for this test are not included, since there was evidence to indicate that a portion of the test material was not satisfactory. A number of the patients had been given diphtheria antitoxin before having the Schick test, a factor which further invalidated the statistics.

The mode of transmission of the diphtheritic infection commonly is presumed to be human carriers. Diphtheria is not rare among the natives, and this was the probable source of the infection. A more detailed report of the epidemiology is being prepared by Livingood and associates.<sup>2</sup>

Most of the cases of cutaneous diphtheria seen in this series developed in combat soldiers who were fighting under the adverse conditions of the monsoon. The intense heat and the constant rain and humidity, together with the complete lack of facilities for any personal hygiene while in combat, caused the men to ignore the many minor injuries which they acquired. This neglect resulted in secondary infection of these injuries. In many instances this included infection with *C. diphtheriae* with the development of the typical chronic ulcers of the skin of cutaneous diphtheria.

At first there was a tendency on the part of medical officers to minimize the importance of such ulcers, treating the men on an active duty status. This policy was dictated in part by military necessity, owing to the acute need for men, and in part by the failure of the physicians to diagnose these ulcers as cutaneous diphtheria. Later, when the cause had been established and the clinical picture became more widely known, it was recognized that the ulcers of cutaneous diphtheria required early and adequate hospital care for prompt healing. Actually, this policy reduced invalidism.<sup>2</sup> Whether the duration of the cutaneous lesions has any bearing on the incidence of neuritis has not been established. It is possible, however, that the chronicity of the lesions in many of these cases may have favored the development of this complication. Neuritis was more likely to develop in those cases with the most severe and the greatest number of lesions. However, there was no correlation between the severity of the cutaneous lesions and the severity of the neuritis. The clinical aspects of the cutaneous diphtheria have been presented elsewhere.<sup>2</sup>

Neuritis and, to a smaller degree, myocarditis are relatively common complications of untreated faucial diphtheria. The incidence, however, of both neuritis and myocarditis can be reduced to a negligible factor by the prompt administration of antitoxin. In this series myocarditis occurred in 5 per cent of the cases.<sup>3</sup> There were 7 cases of myocarditis; 4 were verified and 3 were probable cases. Of the 4 definite cases, neuritis was present in 3, and in the fourth death from cardiac failure occurred on the twenty-third day of the diphtheria. In no case did neuritis develop earlier than the twenty-third day (see table 2). In only 1 of the 3 probable cases was neuritis present. The myocarditis occurs much less frequently, appears earlier and is of shorter duration than the neuritis.

Faucial diphtheria rarely occurred as a result of the cutaneous infection. In 3 of the cases of neuritis faucial diphtheria later developed. This had no obvious effect on the neuritis.

#### CLINICAL PICTURE

The clinical picture of multiple neuritis associated with diphtheria displayed many variations, although the basic pattern was constant.

In many instances the neuritis developed while the ulcers were still active; in others the neuritis first became symptomatic several weeks after the ulcers had completely healed. The average interval between the estimated date of onset<sup>4</sup> of the diphtheritic ulcers and the first evidence of neuritis was 70.4 days; the shortest interval was 23 days and the longest 158 days (table 2).

TABLE 2.—Interval, in Days, Between Onset of Ulcers and Onset of Neuritis

	Interval		
	Average	Shortest	Longest
Group A.....	68.0	24	146
Group B.....	72.0	23	158
Both groups.....	70.4	23	158

While the date of onset of the diphtheritic infection is only estimated, it is interesting to note the correlation between the figures for the two groups shown in table 2.

The neuritis began with involvement either of the cranial or of the peripheral nerves. The frequency with which each was first implicated and the presenting symptom can be seen in table 3. In a few cases

TABLE 3.—Mode of Onset of the Neuritis

Symptom	Number of Cases in Each Class *			Total Number
	Class 1	Class 2	Class 3	
A. Cranial nerve involvement				
Loss of accommodation.....	1	8	8	17
Loss of taste and numbness of tongue...	..	1	..	1
Weakness of palate and pharynx.....	..	..	2	2
B. Peripheral nerve involvement (sensory)				
Numbness and tingling				
Hands.....	7	4	..	11
Feet.....	1	3	..	4
Both.....	10	12	3	25
C. Peripheral nerve involvement (motor)				
Weakness of the extremities.....	1	..	..	1
Total.....	20	28	18	61

\* The classes in table 3 were based on the severity of the neuritis. In class 1 (cases of mild neuritis) there was only sensory involvement. In class 2 (moderately severe) there were sensory signs and symptoms in addition to motor weakness and loss of tendon reflexes. In class 3 (severe) there was definite muscular wasting in addition to the signs and symptoms listed under class 2. Involvement of the cranial nerves could occur in any class, in addition to the aforementioned symptoms.

the onset was almost simultaneous, with involvement of both cranial and peripheral nerves. As can be seen from table 3, the site of

4. Since most of the patients were not seen until some time after the ulcers had developed, the date of onset of the diphtheritic infection had to be estimated from the patient's description of the clinical development of the ulcer. It is recognized that such an estimate cannot be exact, and probably is accurate only within plus or minus 15 days.<sup>2</sup>

onset had considerable prognostic significance. While cranial nerve palsies as the presenting symptom were almost equally common in classes 2 and 3, such a condition occurred only once in class 1. Consequently, the appearance of symptoms referable to the cranial nerves forecast moderately severe or severe neuritis. In further support of this prognostic trend, severe neuritis developed in only 3 of the 40 cases in which onset was with phenomena referable to the peripheral nerves.

The site of the cutaneous lesion or lesions appeared to play no role in determining where the neuritic symptoms would make their first appearance. The distribution of the ulcers was generalized. They occurred on the face, neck, chest, axilla, penis, buttocks and extremities; in many instances there were multiple lesions, widely scattered. However, in 35 cases the lesions were limited to the lower extremities. The neuritis in 4 cases of this group began with numbness and tingling of the feet alone, and in 6 others, with paresthesias of the hands. In the remaining 25 cases the onset was either with paresthesias in all four extremities or with palsies of the cranial nerves. In 25 of the remaining 26 cases of neuritis the cutaneous lesions were so scattered that no conclusions could be drawn concerning this point. It is interesting to note that in the 1 final case, in which an extensive ulcer involved the entire anterior surface of the neck, there first developed numbness and tingling of the hands and feet, and not cranial nerve palsies, although later these did appear.

The clinical course of the neuritis was slow and proceeded in regular sequence through certain definite steps. While in some instances these steps were superimposed, in others they were quite discrete, being separated by a latent asymptomatic period. The steps, in order of their appearance, were (a) cranial nerve, (b) peripheral nerve (sensory) and (c) peripheral nerve (motor) involvement. Cranial nerve palsies developed in 21 (34.4 per cent) of the cases of neuritis. In all these cases, in addition, the peripheral nerves were involved. In 10 cases this involvement was largely confined to sensory changes while in 11 cases the motor components were also affected. The multiple neuritis was limited to the peripheral nerves in the remaining 40 cases (65.6 per cent). In 19 of these cases the involvement was limited to the sensory nerves alone; i. e., paresthesias and alterations in the various modalities of sensation were present (table 4). Motor neuritis occurred in 1 case. In the other 20 cases mixed motor and sensory signs and symptoms were present. The same sequence was maintained with regard to the clinical development of the neuritis even in the absence of cranial nerve palsies.

The first symptom of dysfunction of the cranial nerves was usually blurred vision. The patient noticed that he could not read unless the book was held farther away than was his custom. On examination the patient would be found to have a change in his near point, although gross evidence of paralysis of accommodation was absent. Other symptoms referable to the cranial nerves, including difficulty in swallowing, hoarseness and diminished taste, occurred less commonly. The cranial nerve palsies lasted from ten to thirty days.

TABLE 4.—Frequency with Which Signs and Symptoms Occurred as Related to Severity of Neuritis

Neurologic Symptoms and Signs	Total Incidence		
	Class 1	Class 2	Class 3
<b>Cranial nerves</b>			
(a) Loss of accommodation.....	2	8	10
(b) Numbness of tongue and loss of taste.....	..	2	5
(c) Weakness of: Pharynx.....	..	1	4
Palate.....	..	2	5
Larynx.....	..	..	1
<b>Peripheral nerves</b>			
<b>Upper extremity: Sensory</b>			
(a) Numbness and tingling.....	19	29	12
(b) Hypesthesia to pain and light touch.....	19	29	12
(c) Loss of vibration and position sensation.....	..	..	..
<b>Motor</b>			
(a) Weakness of: Shoulder.....	..	3	5
Arm.....	..	13	9
Hand.....	1	26	12
(b) Wasting			
Interosseus muscles.....	..	4	11
Generalized.....	..	..	6
(c) Loss of tendon reflexes.....	5	29	12
<b>Lower extremity: Sensory</b>			
(a) Numbness and tingling.....	17	29	12
(b) Hypesthesia to pain and light touch.....	17	29	12
(c) Loss of vibration and position sensation.....	1	3	4
<b>Motor</b>			
(a) Weakness of: Hip.....	..	2	6
Quadriceps.....	1	24	12
Feet.....	..	22	11
(b) Wasting			
Quadriceps.....	..	2	10
Generalized.....	..	..	6
(c) Reflexes absent or diminished.....	6	29	12

As these symptoms were clearing up, or after an interval of a week to ten days, the first symptoms of involvement of the peripheral nerves would appear. The patient then would notice numbness and tingling of the hands and feet. At that time the patient generally showed no objective signs, and if there had been no previous cranial nerve palsy the diagnosis could not be positively established. However, in from one to two weeks these paresthesias would be followed by definite objective neurologic changes. Examination then would disclose hypesthesia to pinprick and light touch in a glove and stocking distribution. The sensory distribution varied from one involving only the distal segments (i. e., the fingers and toes) to one which

implicated nearly the entire extremity. Diminished appreciation of heat and cold paralleled the hypesthesia to pain and light touch.

Ataxia was a relatively rare symptom in the lower extremities and was never demonstrable in the upper extremities. In 8 cases with ataxia there was definite impairment of vibration and position senses. In 2 cases this appeared to be due to involvement of the posterior column, a sensory level for vibration being obtained at the eighth thoracic segment in 1 case and at the third lumbar segment in the other. In the remaining cases the sensory changes were limited to the distal segments, being an additional sign of the multiple neuritis. The sensory symptoms and signs persisted in general from four to eight weeks, although in a few cases they lasted up to ten weeks.

In a number of cases the progress of the neuritis ended with the sensory symptoms but in 12 cases there was pronounced involvement of the motor components of the peripheral nerves. While in an occasional case the motor symptoms developed simultaneously with the sensory, most commonly these did not appear until the end of the sensory period or after a latent period of one to four weeks. The most common presenting symptom of motor involvement was the extreme fatigue which these patients noted after any exertion. Neurologic examination at this point usually disclosed diminished strength or loss of tendon reflexes but no readily detectable gross motor weakness. There were no pathologic reflexes, but the general muscular tone was diminished.

Within a week to ten days definite muscular weakness would develop. There was a tendency for certain muscles to be involved predominantly—i. e., the interosseus muscles and the quadriceps. In a few cases the motor weakness was extreme, involving all the extremities and the trunkal musculature. In 2 instances the patients were completely bedridden, unable to do anything for themselves. If the motor involvement was severe, muscular atrophy would appear, particularly in the muscle groups just enumerated. The motor phase lasted from six to twelve weeks. It was difficult at times to evaluate when there was complete return of function, since a few men continued to complain of easy fatigability after all objective signs had disappeared. How often this was motivated by a disinclination to return to combat duty was questionable in a few cases. All the men, however, recovered completely, and the majority were returned to full duty.

Walshe,<sup>5</sup> in his analysis of cases of neuritis following cutaneous diphtheria, reported the frequent early involvement of nerves adjacent to ulcers, which he regarded as due to the local absorption of the

5. Walshe.<sup>1b, c</sup>

toxin. Usually, in these cases the process would go on to development of signs and symptoms of multiple neuritis. In only 1 of our cases was there a clinical course similar to this. The patient had a solitary ulcer over the internal maleolus of the left ankle. His first motor symptom was a left foot drop, although previously he had had involvement of cranial and peripheral (sensory) nerves. The foot drop was quickly followed by symmetric motor involvement of all four extremities. Although other patients had similar solitary ulcers, there were no other local nerve palsies.

The scars of all the cutaneous ulcers, irrespective of whether neuritis had developed, showed varying sensory changes. In the cases of deep penetrating ulcers the scars were anesthetic, and an area of hypesthesia of from 1 to 5 cm. surrounded the scar. The

TABLE 5.—Duration, in Days, of Neuritis in All Cases Irrespective of Severity

Group	Duration		
	Average	Shortest	Longest
A.....	109.5	23	184
B.....	92.3	21	163

TABLE 6.—Average Duration, in Days, in Cases According to Severity of Neuritis

Class	Group A		Group B		Combined	
	No. of Cases	Duration	No. of Cases	Duration	No. of Cases	Duration
1 (mild).....	12	77	8	65.7	20	71.3
2 (moderately severe)...	18	117.1	11	95.09	29	106.1
3 (severe).....	7	145.2	5	131.0	12	138.1

scars of the more superficial ulcers were hypesthetic. In scars of the first type it seemed probable that the anesthesia was due at least in part to tissue destruction. It should be noted, moreover, that any deep, penetrating scar, irrespective of its origin, may remain anesthetic for a long period, owing to tissue destruction. The hypesthesia seen in the "normal" skin surrounding the deep ulcers and in the superficial scars was probably due to local absorption of toxin.

There were no sphincter disturbances in any of our cases. It was felt that this was significant, since a number of patients had ulcers on the buttocks and genitalia.

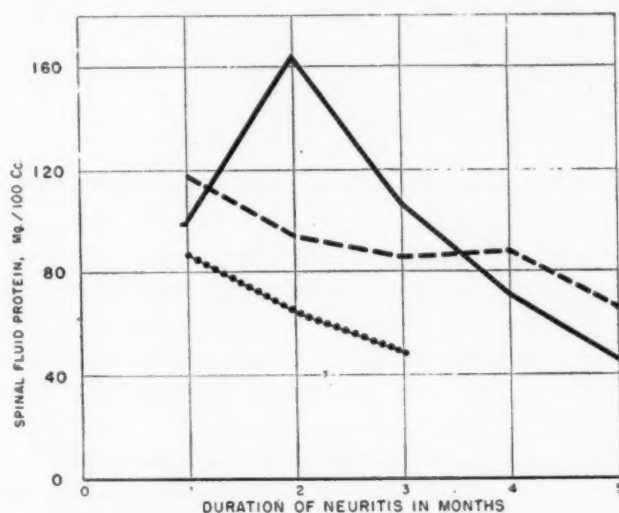
Muscular tenderness was never a prominent symptom, although it was not infrequently found. Rarely was tenderness elicited by direct pressure on the nerve trunks.

The duration of this neuritis was prolonged by the slow sequence of its development (tables 5 and 6). In the average case of neuritis the duration was about one hundred days.

The duration was directly dependent on the severity of the neuritis. For class 1 the average length was seventy-one days; for class 2, one hundred and six days, and for class 3, one hundred and thirty-eight days. There were no residuals, all of the patients recovered completely.

#### LABORATORY STUDIES

All these patients had complete laboratory studies; Blood counts, urinalyses and Wassermann tests of the blood disclosed nothing significant. The blood sedimentation rates were all within normal limits. Examination of the spinal fluid showed a pronounced albuminocytologic dissociation. The cell count was never increased, but the protein was found to be increased early, and this increase persisted throughout the neuritis, gradually returning to within normal



In this graph, the average value of the protein of the spinal fluid for each class is shown. The values for class 1 are shown by the line of dots; the values for class 2, by the broken line, and the values for class 3, by the solid line.

limits. The rise in protein was usually proportional to the severity of the disease; in 1 case it reached 317 mg. per hundred cubic centimeters (graph). This alteration in the protein content of the spinal fluid was helpful in estimating the disability of a number of the men who continued to complain of weakness after all objective evidence of the neuritis had disappeared. In many of these men it was found that the protein level remained high. Later, when it had fallen within normal limits, the patients were asymptomatic.

Material was obtained from all the lesions and cultured for *C. diphtheriae*, and tests for virulence were performed on the positive cultures.<sup>3</sup> The results of these laboratory studies are outlined in table 7. While

the total number of patients with cultures of *C. diphtheriae* which proved virulent was only 25 (17.8 per cent), this does not give a complete picture. During the first six weeks during which the majority of these patients were admitted to the hospital none of the cultures were positive for virulent *C. diphtheriae*, although the diagnosis of cutaneous diphtheria was strongly suspected on clinical grounds. This failure to obtain a higher percentage of positive cultures of the virulent organisms was attributable partly to inadequate culture mediums. When this situation was remedied by material flown from the United States, the number of patients whose condition

TABLE 7.—Results of Examinations of Cultures of Material from Ulcers

	Group A	Group B	Total
Number of cases in which virulent <i>C. diphtheriae</i> organisms were isolated.....	23 (21%)	2 (6.2%)	25 (17.8%)
Number of cases in which organisms with morphologic character of <i>C. diphtheriae</i> were isolated.....	51 (46.8%)	12 (37.5%)	63 (45.0%)
Number of cases in which other organisms (hemolytic <i>Staphylococcus aureus</i> ; hemolytic and nonhemolytic streptococci) were isolated.....	35 (32.2%)	*	

\* Many of the patients in group B came in because of their neuritis after the lesions were largely healed.

was diagnosed clinically as cutaneous diphtheria and who were proved to have infections with virulent *C. diphtheriae* rose to approximately 80 per cent. Cultures of material from the nose and throat were made for all these patients routinely. Only 1 patient with virulent *C. diphtheriae* in the nasopharynx was found. From 13 other patients organisms with the morphologic characteristics of *C. diphtheriae* were isolated. It is quite probable that these results might have been different had adequate culture studies been possible from the beginning.

#### TREATMENT

Treatment of the cutaneous lesions and the myocarditis has been discussed elsewhere.<sup>6</sup> The treatment of the neuritis is largely preventive by the early administration of diphtheria antitoxin in adequate dosage. Unfortunately, many of the patients did not receive antitoxin, or it was not administered early in the course of their cutaneous diphtheria. The only patients who afforded any information as to the effectiveness of antitoxin in the prevention of complications was the A group, who were studied throughout their illness at one hospital. However, this group is not statistically significant, since the number of cases is so limited. The incidence of neuritis was greatly reduced by the administration of antitoxin (table 8).

6. Livingood and others.<sup>2</sup> Kay and Livingood.<sup>3</sup>

Neuritis occurred in only 14 per cent of the patients if antitoxin was given before the thirty-second day and in 30 per cent if it was given later than this. On the other hand, the rate rose steeply to 61 per cent if no antitoxin was given. As in cases of faucial diphtheria, it would appear that antitoxin is of primary importance in the prevention of neuritis.

An interesting observation was made on the duration of the neuritis in the patients who received antitoxin. Twenty-five of the 61 patients with neuritis were given antitoxin, although for 18 of these

TABLE 8.—*Influence of Antitoxin\* on Incidence of Neuritis in Patients with Cutaneous Diphtheria*

	Group Given Antitoxin		
	Before 32d Day †	After 32d Day †	Untreated Patients
Number of patients.....	42	36	31
Number with neuritis.....	6 (14.2%)	10 (30.6%)	19 (61.2%)

\* The dose of diphtheria antitoxin varied from 20,000 to 40,000 U. S. P. units.

† Number of days after onset of the cutaneous diphtheria that antitoxin was given.

25 men this was after the thirty-second day of the infection. As can be seen in table 9, antitoxin was administered to 21 of 37 patients of the A group and to only 4 of the 24 patients of the B group. In the light of this observation it is interesting to compare the duration of the neuritis in the two groups (tables 5 and 6). Actually, the A group, in all classes, had a longer period of disability due to their neuritis than the B group.

TABLE 9.—*Number of Patients with Neuritis Who Received Diphtheria Antitoxin*

	Group A	Group B
Before 32d day *.....	6	1
After 32d day *.....	15	3
Total.....	21	4

\* Number of days after onset of the cutaneous diphtheria that antitoxin was given.

Once the neuritis developed, no therapeutic measures appeared to influence the course of the illness. One-half the patients were placed under treatment with multivitamins and vitamin B complex, but this did not shorten the period of disability. For those patients in whom marked muscular wasting developed physical therapy was of value. Unfortunately, the demands on the physical therapy department were so great that only a few of the most severely affected patients could be given this form of treatment consistently. All the patients were encouraged to take part in the reconditioning program as rapidly as their recovery would permit. Graduated exercises

were given, and each patient was told to stop as soon as fatigue was noticed. The amount of exercise was increased as quickly as the clinical progress would allow.

#### REPORT OF CASES

The 3 cases outlined here were chosen because they illustrate the typical clinical picture of this form of multiple neuritis.

**CASE 1 (class 1).**—The soldier had a number of abrasions and insect bites which developed into typical diphtheritic ulcers; these lesions were undiagnosed for several weeks. On admission he had multiple, small diphtheritic ulcers on his feet and legs. Culture of material from the ulcers yielded virulent *C. diphtheriae* organisms. There was no evidence of neuritis at this time. Shortly after admission to the hospital, on the thirty-third day of his illness, he was given 20,000 U. S. P. units of diphtheria antitoxin. The ulcers healed completely in the next four weeks. On the sixty-second day the first symptoms of neuritis were noted, i. e., numbness and tingling of the fingers and hands. Neurologic examination at this time revealed no objective signs. About a week later the paresthesias had extended to the feet and legs and had involved the forearms. Examination at this time disclosed definite hypesthesia to pinprick and light touch. The picture then remained unchanged for two weeks, but in the next four weeks there was a gradual return of sensory function. The tendon reflexes were diminished, but there was no other subjective or objective evidence of motor involvement. The reflexes did not return to normal until the eighty-seventh day. Determination of the protein content of the spinal fluid in this case gave the following values:

Day of Neuritis	Protein, Mg./100 Cc.
5	120
21	137
61	87
87	42

**CASE 2 (class 2).**—The patient had a number of ulcers on his hands, arms and back, many of them due to shrapnel wounds. Prior to admission to the Twentieth General Hospital he had been treated in a forward medical unit. On his admission to the general hospital physical examination revealed only a number of ulcers characteristic clinically of cutaneous diphtheria. Culture of the ulcers yielded virulent *C. diphtheriae*. On the forty-fourth day of his illness he was given 40,000 U. S. P. units of diphtheria antitoxin. The ulcers were slow to heal, finally clearing on the one hundred and first day.

On the seventieth day of his illness the patient noticed blurred vision and diminished taste sense. Neurologic examination then showed only alteration in the visual near point and impairment of taste sense. The cranial nerve palsies had disappeared in two weeks. One week later he noted numbness and tingling of his hands and feet, which later involved the forearms and legs. Examination then disclosed anesthesia to pinprick and light touch over the hands, forearms, feet and legs up to the knees. There was diminished appreciation of heat and cold in the same distribution. These sensory symptoms cleared in the next four weeks. Toward the end of this period the deep reflexes became hypoactive, and the patient noted generalized weakness, which was most pronounced in his legs when he tried to walk up or down stairs and less in the hands. All the deep reflexes were absent, and there was definite weakness of the extremities, the quadriceps and the interosseus muscles being most severely affected; there

was no wasting. During the next eight weeks there was slow but complete motor recovery. Determination of the protein of the spinal fluid gave the following values:

Day of Neuritis	Protein, Mg./100 Cc.
2	127
13	223
21	210
32	175
67	87
90	70
120	53

CASE 3 (class 3).—The soldier had multiple ulcers on his hands and feet. He was admitted relatively early in the course of his diphtheritic infection and was given 20,000 U. S. P. units of diphtheria antitoxin on the twenty-second day. His ulcers responded rapidly and were completely healed by the sixty-ninth day. At about the end of the fifth week after the onset of the ulcers he noticed blurred vision and difficulty in swallowing. Neurologic examination revealed only alteration in the near point and paresis of the palate. A few days later he noticed diminished taste sensation. These symptoms had entirely disappeared by the twenty-second day. Three days later he reported numbness and tingling of the distal segments of all four extremities. He reported that he could not walk in the dark. Neurologic examination disclosed anesthesia to pinprick, temperature and light touch, involving the distal two thirds of all four extremities. In addition, vibration sense was absent at the ankles but was retained elsewhere, and position sense was lost in the big toes. The sensory changes gradually disappeared after six weeks, but during the last week he became aware of weakness and easy fatigability. This was quickly followed by areflexia, pronounced objective weakness of all extremities and, finally, generalized wasting. Return of motor power was extremely slow, but he had completely recovered by the one hundred and sixtieth day. Values for the protein content of the spinal fluid were as follows:

Day of Neuritis	Protein, Mg./100 Cc.
10	160
41	244
60	260
80	234
130	143
147	115
158	60

#### SUMMARY

Clinical and laboratory observations in 61 cases of multiple neuritis which developed as a complication in 140 cases of cutaneous diphtheria are reported. Characteristic of this syndrome is the late onset of the neuritis after the development of the diphtheritic ulcers. The neuritis began either with symptoms referable to the cranial nerves or paresthesias involving the peripheral nerves. During the clinical development of the neuritis it passed through one or more of the various stages, i. e., cranial nerve, peripheral sensory nerve and peripheral motor nerve involvement. Neither the cranial nerve nor the peripheral motor nerve stage appeared in all cases, but all stages usually occurred in cases of severe neuritis. In 2 cases evidence of a pathologic process in the posterior column was disclosed.

This type of multiple neuritis is distinguished by its slow and insidious course from the more rapidly developing syndrome seen in the infectious polyneuritis of Guillain and Barre. While the albuminocytologic dissociation of diphtheritic multiple neuritis resembles that found in the Guillain-Barré syndrome, here too, there is dissimilarity, since the elevation of the protein in cases of the latter syndrome is much higher.

The laboratory examinations show no consistent changes except for the albuminocytologic dissociation found in the spinal fluid in nearly every case. The elevation of spinal fluid protein is usually proportional to the severity of the neuritis.

Recovery is slow, particularly in cases in which there is motor involvement; but in every case in this series it was complete.

There is little evidence to suggest that local absorption of the toxin played any role in the development of the neuritis.

#### CONCLUSIONS

1. Multiple neuritis is a frequent complication of cutaneous diphtheria. The early administration of diphtheria antitoxin in adequate dosage significantly reduces the incidence of this complication.

2. The clinical development of diphtheritic multiple neuritis is slow and proceeds through a variable number of definite steps.

3. This march of events does not indicate that there is a relationship between the site of the cutaneous lesions and the development of the symptoms.

4. Local paralyses occur rarely and do not appear to play a major role in the development of the clinical picture.

5. A Gullain-Barré type of albuminocytologic dissociation is a concomitant of this form of multiple neuritis and is of considerable value in following the course of the disease.

6. There is no specific treatment for this type of multiple neuritis.

Hospital of the University of Pennsylvania, Philadelphia (4).

## PROGNOSIS IN SO-CALLED SCIATIC NEURITIS

HENRY S. DUNNING, M.D.  
NEW YORK

**I**N RECENT years a common neurologic disease called sciatic neuritis has been found to be caused, in the majority of cases, by herniation of the nucleus pulposus in a lower lumbar intervertebral disk with pressure on nerve roots of the cauda equina. Aware of the belief of some authors that primary sciatic neuritis is a distinct clinical entity (Alpers, Gaskill and Weiss<sup>1</sup>), I maintain that the symptoms and signs of herniation of the nucleus pulposus in the fourth or fifth lumbar intervertebral disk are indistinguishable from the well defined syndrome that was formerly called sciatic neuritis. Cessation of pain after removal of herniated nuclei has been so impressive that whenever this characteristic syndrome appears the question of spinal operation demands consideration. However, cessation of pain has been observed without spinal operation with sufficient frequency to justify the assumption that the defect may be repaired by natural processes. Indeed, there is such evidence in the literature. In 1939 Ekvall<sup>2</sup> reported on the condition of 74 hospitalized patients four to five years after the diagnosis of sciatica had been made. Twenty were free from sciatica. In the remaining 54 patients there was persistence of symptoms, but in 27 of these patients capacity for work was good, even for hard manual labor in 21. In 1944 Grant<sup>3</sup> reported follow-up observations on 93 patients whose sciatica was believed to be due to herniated intervertebral disk but who were not subjected to spinal operation. There was complete recovery in 9 out of 15 bedridden patients and in 12 out of 42 patients unable to work.

In the records of the New York Hospital the diagnosis of sciatic neuritis has been virtually supplanted by that of herniation of the fourth or fifth lumbar intervertebral disk. Assuming that in the majority of cases in which the diagnosis was sciatic neuritis the condition was

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From the Department of Medicine (Neurology), New York Hospital, and Cornell University Medical College.

1. Alpers, B. J.; Gaskill, H. S., and Weiss, B. P.: The Problem of Primary Sciatic Neuritis: An Analysis of Fifty-Five Cases, *Am. J. M. Sc.* **205**:625 (May) 1943.

2. Ekvall, S.: Enquête clinique, au printemps de 1938, sur les cas de sciatique observés durant les années 1933 et 1934, *Acta med. Scandinav.* **101**:1, 1939.

3. Grant, F. G.: Operative Results in Intervertebral Discs, *J. Neurosurg.* **1**:332 (Sept.) 1944.

herniated disk, follow-up information would determine the natural history of this condition and thereby establish a basis for comparing surgical and conservative methods of treatment. Accordingly, by means of questionnaires and reexaminations, satisfactory follow-up information was obtained in 55 cases in which the condition was reliably diagnosed as sciatic neuritis and in which, after careful consideration of the symptoms and signs, there seemed to be no reasonable doubt that the trouble would now be classified as herniation of the fourth or fifth lumbar intervertebral disk. Most of the patients were private and ward patients in the New York Hospital; 2 were outpatients; 1 was admitted to the neurologic service of Bellevue Hospital, and 4 were physicians on the staff of the New York Hospital. All were severely afflicted and had pain in the posterior or posterolateral aspect of one leg, which was increased by stretching the sciatic nerve of the affected leg. Additional symptoms and signs were pain in the lumbosacral region; tenderness in the region of pain; increase of pain on raising the intra-abdominal pressure, as by straining during defecation; diminution or absence of the ankle jerk and, in the distribution of nerve roots from the fourth lumbar to the second sacral segment, inclusive, weakness of muscles, paresthesia and decreased cutaneous sensation. The methods of treatment were numerous, but no patient had a spinal operation. The follow-up period began with the first attack in which a reliable diagnosis of sciatic neuritis was made and ranged from one year and three months to twenty-three years, with an average of five years and one month.

The patients were grouped as follows:

1. Patients who have been continuously free from pain in the leg and lower part of the back since the subsidence of the first attack. For these recovered patients the duration of pain in the leg ranged from eleven days to three years, with an average of seven months. The period since recovery ranged from one year to seven years and eight months, with an average of three years and five months.
2. Patients who have had persistence, recurrence or development of pain in the lower part of the back since the subsidence of pain in the leg. Inconsequential and considerable degrees of pain were reported, but none of the patients mentioned disability from it.
3. Patients who have had persistence or recurrence of pain in the leg with or without pain in the lower part of the back. Three degrees of pain could be defined: inconsequential and not interfering with former activity; considerable but permitting relatively light work; disabling or not permitting any material physical work. In the last category was placed a man who had never done much physical work but who had become addicted to the use of cathartics because straining during defeca-

tion was so painful. Also placed in this category were the 5 patients who eventually had a spinal operation, with resulting relief from pain in each instance. Three of these operations were referred to as "spinal fusion"; 1 was called a "spinal operation"; the other is known to have been the removal of a herniated nucleus pulposus in the fourth lumbar intervertebral disk. The follow-up results are shown in table 1.

TABLE 1.—*Results for 55 Patients with So-Called Sciatic Neuritis Who Were Followed from One and a Quarter to Twenty-Three Years*

	Satisfactory		Unsatisfactory	
	Number of Patients	Per Cent	Number of Patients	Per Cent
Free from pain.....	20	36	..	..
Pain in lower part of back only				
Inconsequential.....	2	4	..	..
Considerable.....	..	..	2	4
Pain in leg				
Inconsequential.....	8	14	..	..
Considerable.....	..	..	16	29
Disabling.....	..	..	7 <sup>a</sup>	13
Total.....	30	54	25	46

The follow-up information offered an opportunity to determine whether the prognosis in cases of so-called sciatic neuritis could be predicted by clinical or laboratory observations. Accordingly, the data on the neurologic signs, namely, the motility and sensory dysfunctions indicating nerve injury, and the total protein content of the spinal fluid, which was the only abnormality revealed by lumbar puncture in these patients, have been tabulated to show any differences in incidence between the patients who had a satisfactory result and those who had an unsatisfactory result. As shown in table 2, there was no difference in the incidence of impairment of the ankle jerk, whereas decreased sensation and weakness were more frequent in the group with a satisfactory

TABLE 2.—*Incidence of Neurologic Signs as Related to Result*

	Group with Satisfactory Results, per Cent	Group with Unsatisfactory Results, per Cent
Impaired ankle jerk.....	50	48
Decreased sensation.....	40	24
Weakness.....	17	8

outcome. As shown in table 3, there was no essential difference in the total protein content of the spinal fluid in the two groups. With 45 mg. per hundred cubic centimeters as the upper limit of normalcy, the protein

content was above this level in approximately half the cases of both groups.

The sex and age distributions in the two groups were as follows: In each group there were almost twice as many males as females. In the group with a satisfactory result the ages of the patients at the time

TABLE 3.—*Protein Content of Spinal Fluid as Related to Outcome in Cases of So-Called Sciatic Neuritis*

Satisfactory Result (14 Cases)	Unsatisfactory Result (12 Cases)
30 mg. per 100 cc.	10 mg. per 100 cc.
30 mg. per 100 cc.	27 mg. per 100 cc.
30 mg. per 100 cc.	30 mg. per 100 cc.
39 mg. per 100 cc.	30 mg. per 100 cc.
40 mg. per 100 cc.	35 mg. per 100 cc.
40 mg. per 100 cc.	40 mg. per 100 cc.
50 mg. per 100 cc.	40 mg. per 100 cc.
50 mg. per 100 cc.	50 mg. per 100 cc.
50 mg. per 100 cc.	50 mg. per 100 cc.
75 mg. per 100 cc.	75 mg. per 100 cc.
75 mg. per 100 cc.	100 mg. per 100 cc.
100 mg. per 100 cc.	50, 100, 200 mg. per 100 cc.
100 mg. per 100 cc.	(3 taps)
75, 100 mg. per 100 cc. (2 taps)	

of the first reliably diagnosed attack of sciatica ranged from 26 to 58 years, with an average of 45 years; in the group with an unsatisfactory outcome the ages ranged from 24 to 63 years, with an average of 38 years. This difference in age distribution suggests that the prognosis is better in the older age period.

For the purpose of therapeutic evaluation, Dr. Bronson S. Ray<sup>4</sup> has submitted follow-up information on 82 of 100 patients from the New York Hospital on whom he operated for the removal of a

TABLE 4.—*Comparison of Results of Conservative and Surgical Treatment*

	Patients Without Operation (55), per Cent	Patients With Operation (82) (Ray), per Cent
Recovery.....	36	60
Residual symptoms		
Inconsequential.....	18	26
Considerable.....	33	12
Disabling.....	13	2

herniated nucleus pulposus in the fourth or fifth lumbar intervertebral disk. The symptoms and signs in these patients undoubtedly would have led, in earlier times, to the diagnosis of sciatic neuritis. The operative procedures and observations were as follows: removal of a

4. From the Department of Surgery, New York Hospital, and Cornell University Medical College.

herniated nucleus pulposus, 76 cases; removal of an unherniated degenerated nucleus pulposus from a ruptured disk, 13 cases; decompression of nerve roots without removal of the nucleus pulposus from an incompletely ruptured disk, 3 cases; no detectable disease of the disk, 8 cases. In table 4 the follow-up results for six months or longer are compared with those for the patients on whom operation was not performed.

#### CONCLUSIONS

1. In a series of cases of the syndrome formerly called sciatic neuritis and now known to be caused, in the majority of instances, by herniation of the nucleus pulposus in the fourth or fifth lumbar intervertebral disk the prognosis was satisfactory without spinal operation in 54 per cent.
2. Although in this series removal of the herniated nucleus promptly relieved pain and bettered the prognosis by 32 per cent, natural processes should be given an opportunity to repair the defect before spinal operation is urged.
3. Neurologic signs and the protein content of the spinal fluid are of no prognostic value.

## SIMILARITY OF CEREBRAL ARTERIOVENOUS OXYGEN DIFFERENCES ON RIGHT AND LEFT SIDES IN RESTING MAN

GEORGE E. YORK, B.S.; EDMUND HOMBURGER

AND

HAROLD E. HIMWICH, M.D.

ALBANY, N. Y.

THE cerebral arteriovenous oxygen differences have frequently been determined in man without taking into consideration whether the venous blood was drawn from the right or the left internal jugular vein. Nevertheless, textbooks of anatomy state that the two internal jugular veins do not necessarily drain symmetric portions of the brain. This difference in drainage has been emphasized by Gibbs and Gibbs<sup>1</sup> and, more recently, by Batson.<sup>2</sup> Only rarely is there a torcular Herophili, a single chamber, in which the venous blood from the cerebral hemispheres and from the basal ganglia mix. Usually the superior longitudinal sinus directs most of its blood to one or the other of the lateral sinuses, while the straight sinus sends its blood to the opposite side. Riggs, cited by Kety and Schmidt,<sup>3</sup> examined 25 autopsy specimens and observed that most of the blood from the superior longitudinal sinus went to the right side in 15 specimens. In 9 specimens the blood from the superior longitudinal sinus in its entirety went to the right lateral sinus, and in 1 specimen, to the left lateral sinus. Knowledge of the venous drainage and of the fact that the higher cerebral parts<sup>4</sup> possess a faster rate of metabolism than the lower

From the Department of Physiology and Pharmacology, Albany Medical College.

This investigation was aided by a grant from the Winthrop Chemical Company Research Fund.

Mrs. Ilse Memelsdorff made the determinations of the glucose and lactate contents of the blood.

1. Gibbs, E. L., and Gibbs, F. A.: The Cross Section Areas of the Vessels That Form the Torcular and the Manner in Which Flow Is Distributed to the Right and to the Left Lateral Sinus, *Anat. Rec.* **59**:419-426, 1934.

2. Batson, O. V.: Anatomical Problems Concerned in the Study of Cerebral Blood Flow, *Federation Proc.* **3**:139-144, 1944.

3. Kety, S. S., and Schmidt, C. F.: The Determination of Cerebral Blood Flow in Man by the Use of Nitrous Oxide in Low Concentrations, *Am. J. Physiol.* **143**:53-66, 1945.

4. Himwich, H. E., and Fazekas, J. F.: Comparative Studies of the Metabolism of the Brain of Infant and Adult Dogs, *Am. J. Physiol.* **132**:454-459, 1941.

(Footnote continued on next page)

areas of the brain might lead one to conclude that the arteriovenous oxygen differences on the right and the left sides, in a resting subject, would not be the same, owing to an unequal uptake of oxygen. Most previous work on metabolism of the brain seems to have been done without consideration of the sources of the cerebral blood, on the assumption that the arteriovenous oxygen differences are the same on the two sides. It is, therefore, the purpose of the present investigation to compare the arteriovenous differences when the venous blood is collected from the right and from the left internal jugular vein.

#### METHOD

The subjects, examined in the postabsorptive state, were patients with mental disease, most of whom had a disorder diagnosed as schizophrenia. Samples of blood were collected with the use of procaine anesthesia while the subjects were lying quietly in bed. Either the right or the left internal jugular vein was tapped first, the order alternating in successive patients.<sup>5</sup> Immediately thereafter, the opposite internal jugular vein was tapped, and finally blood was drawn from the brachial artery. The blood was kept in glass containers over mercury, as previously described,<sup>6</sup> and was analyzed for oxygen,<sup>7</sup> glucose<sup>8</sup> and lactic acid.<sup>9</sup> Oxygen analyses checked to 0.2 volume per cent, and it was found that variations of 1 volume per cent between the arteriovenous oxygen differences on the right and on the left side were within the experimental error. In order to assure accuracy, the samples of blood used for the analyses of glucose and lactic acid were measured from a 1 cc. Van Slyke pipet. Differences in amounts of glucose and lactic acid of 4 and 1.2 mg., respectively, were considered significant. In preliminary observations, it was noted that when the subject exhibited unrest, tension, excitement or active resistance the variations between the arteriovenous oxygen differences on the two sides were significantly greater than the normal average otherwise obtained in a quietly resting subject and were often beyond the experimental error of 1 volume per cent. To maintain a comparison of arteriovenous oxygen differences in resting man, an attempt was made to overcome this difficulty by selecting subjects who it was felt would cooperate, and if that cooperation did not exist the collection of the samples of blood was discontinued.

Himwich, H. E.; Sykowski, P., and Fazekas, J. F.: A Comparative Study of Excised Cerebral Tissues of Adult and Infant Rats, *ibid.* **132**:293-296, 1941.

5. Myerson, A.; Halloran, R. D., and Hirsch, H. L.: Technic for Obtaining Blood from the Internal Jugular Vein and Internal Carotid Artery, *Arch. Neurol. & Psychiat.* **17**:807-808 (June) 1927.

6. Himwich, H. D., and Castle, W. B.: Studies in the Metabolism of Muscle: I. The Respiratory Quotient of Resting Muscle, *Am. J. Physiol.* **83**:92-114, 1927.

7. Van Slyke, D. D., and Neill, J. M.: The Determination of Gases in the Blood and Other Solutions by Vacuum Extraction and Manometric Measurement, *J. Biol. Chem.* **61**:523-573, 1924.

8. Hagedorn, H. C., and Jensen, B. N.: Zur Mikrobestimmung des Blutzuckers mittels Ferricyanid, *Biochem. Ztschr.* **135**:46-58, 1923.

9. Barker, S. B., and Summerson, W. H.: The Colorimetric Determination of Lactic Acid in Biological Material, *J. Biol. Chem.* **138**:535-554, 1941.

## RESULTS

In 40 observations on the oxygen contents of both internal jugular veins and the brachial artery there was a variation in arteriovenous differences of from 0.00 to 1.00 volume per cent, inclusive, between the two sides in 33 patients and from 1.01 to 1.57 volumes per cent in 7 patients. The average variation for all observations was 0.59 volume per cent. There was no specific pattern, for in the group of 33 patients the differences on the right side were greater than on the left side in 14 patients and greater on the left side than on the right side in 18 patients, and in 1 patient the differences for the two sides were equal. Of the other 7 patients, the differences on the right side were greater than those on the left side in 4 and greater on the left side than on the right side in 3.

In 26 observations on the arteriovenous glucose differences, the brain absorbed glucose in 25 patients, and the result was within the experimental error in 1 patient. In 25 observations on the arteriovenous lactate differences, that substance was poured out of the brain in 13 patients and was taken up only once, and the results were within the experimental error for 11 patients. It is striking that in 12 of 15 pairs of values for arteriovenous glucose differences on the two sides and in 9 of 14 pairs of values for arteriovenous lactate differences the components of each pair agreed within the experimental error of the method.

## COMMENT

*Agreement Between Arteriovenous Oxygen Differences on the Two Sides.*—In 33, or 82.5 per cent of these observations, the arteriovenous oxygen differences on the two sides agreed to within 1 volume per cent or less, and in 7, or 17.5 per cent, the differences were in accord from 1.01 to 1.57 volumes per cent. Since the samples of blood were not drawn simultaneously, but in rapid succession, it is possible that differences beyond 1 volume per cent represent changes in the patient's condition, which may have been caused by the transient, painful stimulus which necessarily disturbed the desired resulting state. Whatever the cause for the deviations in some patients, it is important to note the significant agreement between the arteriovenous oxygen differences for the right and for the left side in most subjects. This agreement is not limited to the data for oxygen for usually both members of each pair of arteriovenous glucose differences and each pair of arteriovenous lactate differences were also in agreement with each other. The fact that glucose is absorbed by the brain and lactic acid is poured out by that organ<sup>10</sup> confirms previous work. More important

10. Nims, L. F.; Gibbs, E. L., and Lennox, W. G.: Arterial and Cerebral Venous Blood: Changes Produced by Altering Arterial Carbon Dioxide, *J. Biol. Chem.* **145**:189-195, 1942.

in view of the agreement between the arteriovenous oxygen differences for the two sides is the observation that in most instances the arteriovenous glucose differences and the arteriovenous lactate differences were also in agreement, a phenomenon which extended to include the arteriovenous pyruvate differences<sup>11</sup> for the two sides.

*Physiologic Basis.*—Not all areas of the brain metabolize at the same rate. In general the newer phyletic layers possess a faster metabolism.<sup>4</sup> It is surprising that the internal jugular vein draining the major portions of the cerebral hemispheres does not exhibit a greater arteriovenous oxygen difference than the opposite vein. The question arises whether the vascularity of any given cerebral region is related to the rate at which its oxidations take place.

An investigation of this problem was undertaken by Craigie,<sup>12</sup> who studied the relative vascularity in the component parts of the rat brain. He found that the gray matter is more vascular than the white and that gray matter may be sharply divided into two groups, the motor nuclei and the nuclei with higher integrative functions, the latter being most richly supplied with blood vessels. He concluded that the differences in vascularity implied a corresponding degree of metabolic activity in the regions concerned.

Dunning and Wolff<sup>13</sup> made similar studies on the cat. They found that the white matter in the brain has the lowest vascularity, and since it possesses the lowest metabolic rate<sup>14</sup> this correlation is in agreement with Craigie's hypothesis. Not only does the gray matter differ from the white, but in the cat, as in the rat, the various parts of the gray matter differ among themselves as to vascularity. According to Dunning and Wolff,<sup>13</sup> the differences probably resemble the order of the metabolic rates in the same cerebral areas.

The observation that the right and the left internal jugular vein usually contain similar volumes of oxygen in the quietly resting subject can, therefore, be explained if the parts of the brain with intrinsically lower metabolic rates possess a smaller structural vascular accompaniment. With such an arrangement, the region receiving the smaller amounts of blood would also consume less oxygen, tending toward an

11. Himwich, W. A., and Himwich, H. E.: Pyruvic Acid Exchange of the Brain, *J. Neurophysiol.* **9**:133-136, 1946.

12. Craigie, E. H.: On the Relative Vascularity of Various Parts of the Central Nervous System of the Albino Rat, *J. Comp. Neurol.* **31**:429-464, 1919-1920.

13. Dunning, H. S., and Wolff, H. G.: The Relative Vascularity of Various Parts of the Central and Peripheral Nervous System of the Cat and Its Relation to Function, *J. Comp. Neurol.* **67**:433-450, 1937.

14. Holmes, E. G.: Oxidations in Central and Peripheral Nervous Tissue, *Biochem. J.* **24**:914-925, 1930.

equalization of the oxygen content in the right and the left cerebral venous return. This hypothesis can be tested by determining simultaneously the arteriovenous oxygen difference and the blood flow on the right and those on the left side.

#### SUMMARY AND CONCLUSIONS

In 40 observations on resting human subjects with mental diseases, the cerebral arteriovenous oxygen differences for the two internal jugular veins varied from 0.00 to 1.00 volume per cent in 33 subjects and from 1.01 to 1.57 volumes per cent in 7 subjects. Similarly, in 12 of 15 determinations of arteriovenous glucose differences for the right and the left jugular vein and in 9 of 14 determinations of arteriovenous lactate differences for the right and the left jugular vein, the members of each pair differed from each other only within the experimental error. This agreement is surprising in view of the fact that the two internal jugular veins do not necessarily drain symmetric portions of the brain. In explanation of this agreement, it is suggested that the vascular structure of any given cerebral region is in proportion of its metabolic demands.

NOTE.—The paper by Gibbs, Lennox and Gibbs (Bilateral Internal Jugular Blood: Comparison of A-V Differences, Oxygen-Dextrose Ratios and Respiratory Quotients, *Am. J. Psychiat.* 102:184-190, 1945), which has appeared since our own communication was submitted for publication, likewise points out the similarity of the cerebral arteriovenous differences on the right and left sides.

Albany Medical College (3).

## PHENOMENA OF SENSORY SUPPRESSION

MAJOR NORMAN REIDER

MEDICAL CORPS, ARMY OF THE UNITED STATES

RECENTLY Bender and Furlow<sup>1</sup> reviewed the literature and described their case of an interesting sequel to cerebral injury similar to a syndrome first noted during World War I. Briefly, this syndrome consists in the extinction, suppression or obscuration of the perception of an object in an "affected" field of vision when an object is presented simultaneously on the other, or "normal," side of the central point of fixation. In persons with this disturbance, who have suffered injuries primarily of the parieto-occipital cortex, an object is visible in the "affected" field provided there is no strong stimulation in the unaffected field. This phenomenon had previously been attributed by various authors to a defect in the patient's attentiveness. Bender and Furlow, however, pointed out in their report that the factor of attention provides only a partial explanation of what occurs in the syndrome. They elucidated the matter further by using Goldstein's proposal<sup>2</sup> that the phenomenon may be due to the lability of threshold in the damaged cortex, which needs more energy than the normal. Moreover, one must consider rivalry and dominance mechanisms of the two cerebral hemispheres in explanation of the psychologic mechanisms underlying the phenomenon.

In a later paper Bender<sup>3</sup> noted similar competitive mechanisms between cutaneous sensations on the two sides of the body in patients with lesions of the parietal cortex.

The syndrome has many variations and degrees of intensity. In some patients it is the basis of their major complaint; in others it is accidentally discovered. Five cases of the condition were observed in an Army general hospital, and a new clinical feature in 2 of these cases leads to the following report, which substantiates in the main the previous observations and provides additional information in understanding the complicated mechanisms involved.

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Read at a meeting of the New York Neurological Society, Dec. 11, 1945.

1. Bender, M. B., and Furlow, L. T.: Phenomenon of Visual Extinction in Homonymous Fields and Psychologic Principles Involved, *Arch. Neurol. & Psychiat.* **53**:29-33 (Jan.) 1945.

2. Goldstein, K., in discussion on Bender and Furlow.<sup>1</sup>

3. Bender, M. B.: Extinction and Precipitation of Cutaneous Sensations, *Arch. Neurol. & Psychiat.* **54**:1-9 (July) 1945.

## REPORT OF CASES

CASE 1.—A 24 year old soldier was struck on the head by a falling log. A nail protruding from the log penetrated his skull in the left occipitoparietal area 2 cm. from the midline. He was unconscious only momentarily but was dazed for a few minutes. Immediately on regaining consciousness, he noted that voices sounded as though they were in the distance; in addition, he had a great deal of difficulty with his vision. He was hospitalized within twenty minutes. He found that he was most comfortable while keeping the eyes closed. That night he had fever and vomited. The next day he was operated on; the details of the operation are not known except that he was told that "a little blood was washed out." Ten days after the operation he had fever again and an extremely severe headache, lasting three or four days. He received penicillin for four days, and the fever subsided. The headaches persisted for two weeks, and he was then evacuated from the combat zone. Gradually his vision began to improve, but for two months he could not see to the right. After a period of convalescence he was returned to duty.

Eight months after the accident, while talking to friends, he suddenly saw straight "bars" before his eyes and fell unconscious. His friends told him that he had a generalized convulsion. He was confused and groggy. He spent the next four days in bed. During this time his vision was blurred again but gradually returned to normal. Six weeks later, while seeing a movie, he suddenly saw spots before his eyes and lost consciousness for fifteen minutes, during which he had a convulsion. This second convulsion led to his being sent to the hospital for study, ten months after his injury.

He gave the following information concerning visual disturbances which he had noticed ever since recovery from the acute phase of his illness. While playing Ping-pong, he would frequently miss the ball if it was to his right. While driving a car, he was not certain whether he had passed an object to his right or not. His reading ability had slowed up considerably. He frequently made mistakes in writing and was not aware of the error in spelling until he was writing the next word. He had often noticed some difficulty in finding the right word in speaking and frequently had to ask people to repeat what they had said to him. At movies or at shows he noted that he could not recognize jokes or funny actions as quickly as he used to. Nevertheless, he did not think his sense of humor was impaired. He had not noted any emotional disturbances or change in appreciation of music, but when he tried to read music he had great difficulty in interpreting what he saw. He had never noted any difficulty in the appreciation of color.

At drill he noted that he frequently bumped into the soldier on his right. He was disturbed to find himself confusing right and left. By the time he was admitted for study, however, all the aphasic manifestations had disappeared.

He noted also that when he was perfectly still he could judge distances very accurately. However, if he was moving or driving a car, he had difficulty in judging distance. For instance, when playing basketball, he could shoot accurately while standing perfectly still; but if he tried to shoot while moving he made frequent errors. This observation is reminiscent of some of the disturbances noted by Riddoch.<sup>4</sup>

4. Riddoch, G.: Visual Disorientations in Homonymous Half-Fields, *Brain* 58:376-382, 1945.

After he had returned to duty, his visual difficulties led him to report on sick call several times. Each time visual acuity and perimetric measurements were normal. He was told there was nothing wrong with his eyes and that he was probably "imagining" his complaints.

Physical examination eleven months after his injury revealed no abnormalities. He was right handed and right eyed. His intelligence was superior. Neurologic examination revealed that motor power was excellent throughout; all deep and superficial reflexes were active and equal on the two sides, with no pathologic reflexes. Sensation, coordination and the cranial nerves were entirely normal. Visual acuity was 20/20 in each eye. Form and color fields were entirely normal. Roentgenograms of the skull revealed no abnormalities. Electroencephalographic study (Major Robert L. Craig) showed a normal, 10 per second rhythm in all leads, but with asymmetry in amplitude, the waves from the right occipital lead being of higher amplitude than those from the left. An occasional isolated spike occurred in the left frontal lead. Hyperventilation was not productive of any unusual changes.

Further examination disclosed that he could recognize objects in the right field of vision perfectly well, but when another object was introduced in the left field of vision the object on the right disappeared. Moreover, a quadrantic difference existed. If the initial object was within the right superior quadrant, it often became blurred or obscured rather than disappearing. If stimulation of the left field was strong, such as that with an intense light, the object in the right field disappeared completely. However, it returned within two to four seconds after the stimulation on the left was discontinued. If the object was in the right inferior quadrant of vision and stimulation of the left field was begun, it disappeared immediately and reappeared in from five to twenty seconds, the period of lag depending inversely on the strength of the stimulus. The same phenomenon occurred when either one or both eyes were tested.

Furthermore, if an object was in the right inferior field of vision and the right superior field was stimulated, the object in the right inferior field disappeared or became obscure, the determining factor being the strength of the second stimulus.

When colored test objects were used, the fading of color to gray in the affected fields, as mentioned in Bender's case, could not be elicited in this patient. Either he recognized the color or it disappeared completely, there being at most a diminution in the intensity or hue. The patient could recognize form and contour perfectly. Localization in space, ability to fuse objects and stereoscopic vision were also intact. Visual imagery and memory were normal. After-imagery persisted longer in the left eye than in the right. Objects exposed to the right field of vision for less than a second were not recognized. If a strong light was present in the left field of vision, it often took him as long as four seconds to recognize an object on the right.

Prolonged fixation on the center of a white cross produced no change in the color of the arms of the cross but gave the illusion that the horizontal arm of the cross in the right field of vision became dull. The latter change, however, was never sufficient for him to identify the color as gray.

In writing columns of figures, the patient tended to displace the columns toward the left. When his attention was called to this phenomenon, he wrote in a straight line; but as soon as his attention relaxed the column again tended toward the left side of the page.

All psychologic tests were performed most satisfactorily, and no defects could be discovered except that he could no longer do simple algebraic equations, though he had done well in algebra in college. Complicated arithmetical problems were performed satisfactorily. However, he stated that he was slower than previously. Apropos of these observations, the patient volunteered that algebraic symbols seemed to have lost their meaning to him, though, surprisingly enough, there was no other symbolic impairment.

CASE 2.—A 27 year old soldier in combat was struck by shell fragments in the right parietal region. He was transported to a rear echelon installation, where on admission he was found to be in stupor and had left hemiplegia.

Roentgenographic examination at this time revealed a "punched-out, debrided fracture in the posterosuperior portion of the right parietal bone, measuring 5 by 7 cm. There were some intracranial fragments of bone, as well as an intracranial metallic fragment, 5 by 18 mm., just behind and within the posterior margin of the defect." On the twenty-second day after injury a cranioplasty was performed. The fragments of bone and metal were removed, and a tantalum plate was used to repair the defect in the skull.

Examination four months after the injury showed that he was right handed and right eyed. Neurologic examination revealed the following condition on the left side: The patient had the typical spastic gait of hemiplegia. About 50 per cent of normal strength was present, though the face was hardly involved at all. There was plastic rigidity of the arm and leg. No clinical evidence of atrophy or tenderness was present. Pseudoathetoid movements of the arm and fingers were noted; marked ataxia and dysidiadokokinesia were present. The deep reflexes were more active on this side than on the right. Chaddock and Hoffmann signs were present. Light touch sense was intact everywhere. Hemihypalgesia was present, being most noticeable in the fingers and toes, with pronounced hyperpathia in the toes. Pinprick here provoked a withdrawal response. The patient complained that it felt as though the needle were "digging in." At other times he complained that a single pinprick felt as though a "shower of needles" were hitting his foot.

Appreciation of vibration was absent distally in both the upper and the lower extremity. Appreciation of position was absent, even in the larger joints on the left side. Two point discrimination and stereognosis were lost in the left hand; he did not appreciate skin writing on the left hand or foot. Tactual localization was inaccurate. Examination of the cranial nerves, including the fundi, showed a normal condition. Incomplete left homonymous hemianopsia was present. In the intact left homonymous superior sector a visual suppression phenomenon could easily be elicited; an object here disappeared when a similar object was placed in the right field of vision.

There was left nerve deafness only for the upper tone range. On first examination an auditory suppression phenomenon was thought to be present. While listening to a tuning fork with the left ear, he stated that his hearing on the left disappeared if a tuning fork was brought close to the right ear. Careful checking with an audiometer revealed that attention was the major factor, for the side receiving the second (new) stimulus seemed to be the only side being stimulated. It was possible with the audiometer to demonstrate auditory suppression on either side by stimulating the contralateral side.

Throughout all the sensory tests there was occasionally a latent period of one-half to three seconds from the moment the left side was stimulated to the

perception of the stimulus regardless of the type of stimulus. This initial latency was most pronounced in the foot and least in the face.

A true suppression phenomenon was obtained in the cutaneous sensory fields by means of double stimulation. If one stroked his left foot, he perceived it clearly. If while this stroking continued his right foot was stimulated, sensory perception from the left foot would disappear in two or three seconds. If the stimulation of the right foot was discontinued while it was continued on the left, sensory perception returned after a delay of from five to forty seconds. The duration of the lag depended on the strength of the stimulus on the right side. The same phenomenon occurred for heat, cold and pinprick, but the lag in sensation was not nearly as great as for rubbing.

If the left hand was stroked, sensation disappeared when similar stroking of the right hand was begun. The disappearance of sensation in the left hand occurred from one to two seconds after initiation of stimulation of the right hand. After discontinuation of the stimulation on the right side and continuation of stimulation on the left, sensation would return to the left hand in from two to fifteen seconds. Again, the lag depended on the strength of stimulus applied to the right. Similarly, if the right side of the face was stroked, with concomitant stroking of the left side of the face, the sensation would disappear promptly from the left side in one or two seconds and would reappear within a second or two after the stimulation of the right side of the face had been discontinued. At times, however, the sensation diminished rather than disappeared.

Not only was this suppression of cutaneous sensation effected by contralateral stimulation, but it was elicited on homolateral stimulation. A gradient appeared as follows: If the left foot was stroked, sensation was perceived as usual. If, then, the left hand was stroked, sensation from the left foot either became diminished or disappeared entirely within two to five seconds, the determining factor being the strength of stimulus applied to the hand. The return of sensation to the left foot on discontinuance of stimulation to the left hand occurred in two to five seconds. Similarly, stroking of the left side of the face caused disappearance of the perception of the sensation in either the left hand or the left foot, but this time the effect occurred within two seconds after discontinuation of stimulation to the face. At times, however, especially if the stimulus to the face was very light, there was no diminution of sensation in the hand or foot. However, if the stimulation of the left side of the face was prolonged and strong, secondary stimulation of the left hand or foot would not be perceived at all.

A check on the observations here described was made by initiating sensation on the right side of the body, with the following results: When the right foot was stroked continuously and then stroking of the left foot was begun, the initial strokes on the left foot were perceived and promptly identified by the patient. However, after two to ten seconds of double stimulation the sensation of stimulation began to fade on the left side and then disappeared. The disappearance persisted only so long as the right side continued to be stimulated, and sensation reappeared in two to ten seconds after discontinuation of the stimulation on the right. In like manner, if continuous stimulation of the right side of the face was begun and then the left hand or the left side of the face was stimulated, the stimulus to the left hand or to the left side of the face was perceived immediately but faded within a few seconds. The strength of stimulus was the determining factor in whether the sensation in the hand disappeared completely or not. The table presents the results of the various tests.

In all these experiments the stimulus of rubbing the skin was found most amenable to testing and timing. The phenomenon could also be elicited from other parts of the body, including the trunk, but heavier stimuli were necessary. In all the tests it was impossible to avoid summation effects. Single stimuli did not satisfy the conditions for testing.

Six months after the injury, the soldier was walking without the aid of a cane, his power had increased, and position sense had returned to the large joints but not to the fingers or toes. The phenomenon of visual suppression had disappeared completely and could not be elicited. However, the phenomenon of sensory cutaneous suppression could be elicited without difficulty.

Electroencephalographic tracings were obtained five and six months after the injury. These showed a fairly regular, 11 per second rhythm in the left hemisphere. The right hemisphere showed lower voltage in the temporal lead and irregular activity in the occipital lead. There was no evidence of epileptogenic foci and no change on hyperventilating. Numerous experiments were made with both monopolar and bipolar leads in an attempt to find electroencephalographic changes during the suppression phenomena, and none were found.

*Timing of Cutaneous Suppression Phenomena\**

	Continuous Stimulation of Left Side					
	Left Foot		Left Hand		Left Side of Face	
	D †	R †	D †	R †	D †	R †
Secondary stimulation of right (contralateral) side						
Right foot.....	2-3	3-40	2-8	2-10	2-8	1-2
Right hand.....	2-5	5-20	1-2	2-15	2-5	1-2
Right side of face.....	2-8	2-20	2-5	2-15	1-2	1-2
Secondary stimulation of left (homolateral) side						
Left foot.....	...	...	‡	‡	‡	‡
Left hand.....	2-5	2-5	...	...	‡	‡
Left side of face.....	0-2	2-5	0-2	0-2	...	...

\* The region first stimulated is indicated in the horizontal row; the region secondarily stimulated is indicated in the vertical column.

† D indicates time, in seconds, required for disappearance of perception in the first areas stimulated after stimulation of the second (suppressing) zone is begun; R, time, in seconds, of reappearance of perception in the first area after the suppressing stimulation is discontinued.

‡ In the secondarily stimulated zone the stimulus is perceived, and perception then fades in two to ten seconds under the suppressing influence of the less damaged zone.

Speculatively, following the work of Dusser de Barenne and associates,<sup>5</sup> von Bonin and associates,<sup>6</sup> Garol<sup>7</sup> and others who demonstrated the presence of "suppressor strips" in the sensory cortex, one might expect to find during the suppression phenomenon noted in this case a suppression of the electroencephalographic activity over the

5. Dusser de Barenne, J. G.; Garol, H. W., and McCulloch, W. S.: Physiological Neuronography of the Corticostriatal Connections, *A. Research Nerv. & Ment. Dis., Proc.* **21**:246-266, 1941.

6. von Bonin, G.; Garol, H. W., and McCulloch, W. S.: The Functional Organization of the Occipital Lobe, *Biol. Symposia* **7**:165, 1942.

7. Garol, H. W.: The Functional Organization of the Sensory Cortex of the Cat, *J. Neuropath. & Exper. Neurol.* **1**:320-329, 1942.

sensory cortex. Several possibilities are offered in explanation of why such a suppression was not obtained. It is likely that the electroencephalographic changes which did accompany the phenomena occurred in such a small area that they could not be picked up with available apparatus. Moreover, the presence of the large tantalum plate may have been an additional factor by increasing the area from which the cortical activity was being picked up, thus furnishing too large an area for translation of a suppression phenomenon occurring in a smaller focus.

#### COMMENT

The clinical phenomenon observed in these 2 cases is manifest as a diminution of sensory perception, with gradations from a slight diminution to complete disappearance. Previously this syndrome has been called an "extinction phenomenon," clinically a partially adequate descriptive term; herein it is preferred to call it a "suppression phenomenon." In doing so, the hypothesis is offered that the eventual explanation of the syndrome may be correlated with "suppressor strips," already described by neurophysiologists. No clinical evidence for support of the hypothesis is present; yet Garol<sup>8</sup> defended the thesis on theoretic grounds. These cases certainly corroborate the contention of Bender and Furlow that the phenomenon cannot be wholly explained on the basis of attention. Moreover, the evidence from double stimulation of the homolateral field in these cases indicates that cerebral rivalry cannot in itself be considered a complete explanation either. The phenomenon is undoubtedly a very complex one. The evidence from the cases here presented seems to point toward a primary and basic dependence on a physiologic suppressor action exerted by normal or less damaged tissue, when stimulated, over a damaged sensory cortex. There is some reason to believe that the dynamic concept of utilization of energy is a tenable one and that in some unknown way the damage makes it possible for a healthy tissue to use up all available energy, leaving less or no available energy for the damaged sensory cortex. From the review of all the cases so far reported, a definite impression exists that a lesion in the parietal lobe, or, probably more specifically, a lesion in parietal association fibers, is part of the underlying pathologic substratum of the syndrome.

It is interesting, and perhaps not entirely too far afield, to speculate on the possibility that the phenomenon of attention itself may in some way have a physiologic basis dependent on the function of the parietal lobe. The clue to this speculation lies in the details of the reported cases, in which attention directed toward a sensory perception could

8. Garol, H. W.: Personal communication to the author.

influence that perception to a greater degree whenever that stimulus was functionally connected with a damaged area.

An interesting clinical feature must be stressed. Primary stimulation of the normal side did not prevent the preception of stimuli on the damaged side. The suppression effect, however, went into operation a few seconds after the secondary perception was initiated. This illustrates the well known normal experience of a new stimulus taking precedence over an older one and emphasizes how attention is a factor, though a minor one, in the suppression phenomenon.

Another outstanding point is that in the present cases there seems to be clearcut evidence that the suppression phenomenon not only can be exerted by healthy cortex of one side over diseased cortex on the other but may be exerted homolaterally by less damaged tissue over more damaged tissue. The latter phenomenon is quite in keeping with the experimental observations of neurophysiologists<sup>9</sup> who have shown that suppressor strips exert homolateral, as well as contralateral, influence.

The history in 1 of the cases here presented illustrates that even though visual fields for form and color are normal after an injury one may be missing the reason for continued visual complaints after head injury unless one tests specifically for suppression. How frequently the suppression phenomenon exists after a transient hemianopsia is unknown, but my impression is that it is much more frequent than has been recorded previously.

#### CONCLUSION

Clinical studies on suppression phenomenon are reported in which stimuli originating in a normal, or relatively normal, sensory field tended to inhibit or abolish the perception of stimuli arising from an "affected" field.

When this phenomenon involves vision, in the presence of normal visual acuity and normal perimetric fields, it may be mistaken for a post-traumatic neurotic reaction. The mechanisms underlying the pathophysiologic changes are discussed, emphasis being placed on the fact that the phenomenon may be elicited not only by contralateral but by homolateral stimuli. Theoretic implications of the phenomenon are mentioned.

74 Perry Street, New York 14.

9. Dusser de Barenne, Garol and McCulloch,<sup>5</sup> von Bonin, Garol and McCulloch,<sup>6</sup> Garol.<sup>7</sup>

## BILATERAL CONGENITAL ARTERIOVENOUS COMMUNICATIONS (ANEURYSM) OF THE CEREBRAL VESSELS

RUDOLPH JAEGER, M.D.  
PHILADELPHIA

AND  
ROY P. FORBES, M.D.†  
DENVER

CEREBRAL arteriovenous aneurysms have frequently been recorded in the literature. However, prior to the brief account of this case<sup>1</sup> the occurrence of bilateral cerebral arteriovenous communications had not been reported. A more detailed description of this case, amplified with illustrations and photographs, seems desirable at this time, in the light of the disclosure at operation and necropsy of a second case by one of us (R.J.) reported in the ARCHIVES by Alpers and Forster,<sup>2</sup> and 2 similar cases described by Russell and Nevin.<sup>3</sup> The case here reported is also of unusual interest because of the prolonged period of observation and the opportunity for thorough study at frequent intervals from birth until death, at the age of 4½ years.

### REPORT OF A CASE<sup>4</sup>

S. K., a male infant weighing 9½ pounds (4,310 Gm.), was delivered with difficulty by forceps. Respiration began immediately, but about two minutes later he collapsed, ceased breathing, became cyanotic and was revived with difficulty. The pregnancy had been abnormal in that the mother had continued to menstruate. In an examination at term, Dr. Walter Reed, of Boulder, Colo., the attending physician, noted that the head seemed abnormally large. A roentgenologic examination of the mother's pelvis confirmed this impression and also showed that the

† Dr. Forbes died Nov. 8, 1943.

From the Department of Neurologic Surgery, Jefferson Medical College and Hospital, Philadelphia, and the Childrens Hospital, Denver.

1. Jaeger, J. R.; Forbes, R. P., and Dandy, W. E.: Bilateral Congenital Cerebral Arteriovenous Communication Aneurysm, *Tr. Am. Neurol. A.* **63**:173, 1937.

2. Alpers, B. J., and Forster, F. F.: Arteriovenous Aneurysm of Great Cerebral Vein and Arteries of Circle of Willis, *Arch. Neurol. & Psychiat.* **54**:181 (Sept.) 1945.

3. Russell, D. S., and Nevin, S.: Aneurysm of the Great Vein of Galen Causing Internal Hydrocephalus: Report of Two Cases, *J. Path. & Bact.* **51**:375, 1940.

4. Dr. Walter Dandy, who recently died, and Mrs. Dorcas Hager Padget, of Johns Hopkins Hospital, Baltimore, gave invaluable assistance in the study of the specimen in this case. All the drawings were made by Mrs. Padget.

bones of the infant's skull were thicker than normal. Two previous pregnancies had been normal, and a boy, 8 years old, and a girl, 6 years old, were living and well. The family history was without significance except for congenital heart disease in two cousins.

At birth the head was noticeably large, but the fontanels were closed normally. There was no heart murmur or other abnormality. Breast fed for two months, the infant thrived and continued to gain on a formula. Some prominence of the veins of the head was noted during early infancy.

*Course of Disease.*—At the age of 8 months the child had a severe attack of "flu" and was ill about eight weeks. After this illness he began to have attacks of epistaxis; soon after this a heart murmur was discovered, and it was noted that the area of cardiac dullness was increasing. "Fainting spells" also appeared at this time, and he had four or five such episodes, each lasting about five minutes. There were no convulsions.

At the age of 15 months he was brought to Denver for a pediatric opinion and came under the observation of one of us (R. P. F.). He was large for his age (weight, 26 pounds [11.8 Kg.]). The head was large; the bosses were prominent, and a Harrison groove was noted. He was exceedingly pale, and the eyes and veins of the face were prominent. The heart was symmetrically enlarged about one third above the normal size, according to physical and roentgenologic observations; and a soft, blowing systolic murmur was heard at the base in the third and fourth interspaces. The hemoglobin concentration was 55 per cent (Sahli); the red cells numbered 3,950,000 and the white cells 8,750, with a normal differential cell count. A diagnosis of congenital heart disease was made, and cod liver oil and iron were prescribed.

At 17 months of age he had a second infection of the upper respiratory tract, after which the attacks of epistaxis became frequent and alarming. A third infection in the head, at the age of 20 months, was accompanied with uncontrollable nosebleed and acute otitis. He was admitted to Childrens Hospital (Denver) after he had fainted, apparently from loss of blood. The bleeding failed to stop with nasal packs, and a cautery was used. The hemoglobin was 38 per cent (Dare), the red cell count 3,200,000, the blood calcium 11.1 mg. per hundred cubic centimeters, the platelet count 195,000, the coagulation time three minutes and the bleeding time one minute. The reaction to the Mantoux test was negative, and the electrocardiographic tracing was normal. He had two blood transfusions from the mother, receiving 140 and 200 cc. The hemoglobin rose to 52 per cent. He was discharged in two weeks with a diagnosis of congenital heart disease, rickets and anemia.

A month later he was readmitted to the hospital with an acute infection of the left mastoid. Operation was performed by Dr. Harry L. Baum, and the child left the hospital ten days after operation in fair condition, only to return in two weeks because of severe epistaxis. The bleeding was controlled promptly with packs, and he was discharged the following day. He was taken to California for a month but spent three weeks of the time in a hospital because of severe attacks of epistaxis.

At the age of 27 months an infection of the upper respiratory tract was followed by severe nosebleeds, and he was brought to Childrens Hospital for his fourth admission. The laboratory reported that the hemoglobin was 35 per cent, the red cell count 2,000,000 and the white cell count 8,100, with 39 per cent polymorphonuclear leukocytes. For the first time since he had come under observation a loud bruit was discovered in the neck, being loudest on the left side just below the ear. It could not be heard over the cranium. The cardiac murmur

was still present, being loudest in the third left interspace, and the heart was enlarged. The veins of the face and scalp were prominent, especially before an attack of epistaxis. The right angular vein sometimes appeared to be about one-half the size of the small finger. The patient could frequently tell the nurses that he was going to have nosebleed five minutes before the attacks began. After these attacks he seemed to feel better and the superficial veins were smaller. Bleeding occurred every two to six days. The shorter the interval the less severe the epistaxis and vice versa. Roentgenographic examination showed diffuse thickening of the skull and moderate enlargement of the heart in the transverse



Fig. 1.—Photograph of patient at 3 years of age. Note the enlarged head and dilated veins on the left side of the face and forehead.

diameter. Some evidence of early healed rickets was visible in the epiphyses of the long bones. The blood pressure was 86 systolic and 58 diastolic. Lumbar puncture and ophthalmic examination revealed nothing of significance. Treatment consisted of two transfusions, of 150 and 125 cc. respectively, from the mother. The hemoglobin on his discharge after four weeks was 43 per cent (Dare).

At this time it was of course obvious that some defect in the circulatory system of the head was causing the engorgement of the veins, the epistaxis and probably the thickened and enlarged skull. An arteriovenous aneurysm was suspected.

Within a month the patient was brought back to the hospital because of uncontrollable epistaxis. The hemoglobin was 42 per cent (Dare) and the red cell count 2,750,000. Later the hemoglobin dropped to 28 per cent (Dare). He remained in the hospital six weeks and received three intravenous and three intraperitoneal injections of blood, totaling 855 cc. The hemoglobin was 44 per cent on his discharge from the hospital.

At the age of 3 years the attacks of epistaxis gradually ceased, to be replaced by intermittent headaches and vomiting, which recurred at intervals of several days to three weeks. Between attacks the boy's behavior was normal, and he made a gradual gain in weight.

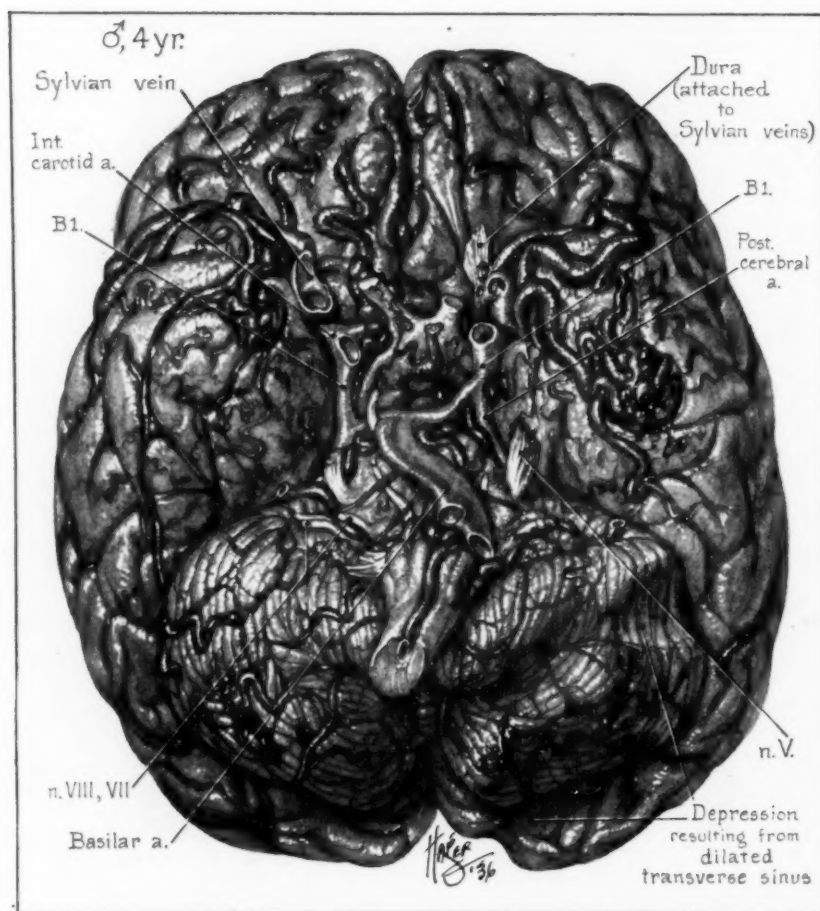


Fig. 2.—Basal view of the brain, showing the dilated, tortuous veins, which encroach on the cranial nerves and are particularly concentrated at the temporal lobes, from which they drain into the cavernous sinuses. All the cerebral arteries are abnormally large, and the circle of Willis exhibits a frequent variation which is a retention of the embryonic condition: The posterior communicating arteries (*B 1*; compare diagram, fig. 5) are large and directly continuous with the posterior cerebral arteries, so that the latter appear to arise from the internal carotid rather than the basilar artery. Each posterior cerebral artery gives rise to an anomalously large artery (representing the posterior choroidal), which empties directly into the internal cerebral veins (Galen).

At 4 years of age his weight was 39 pounds (17.7Kg.) and the hemoglobin was 71 per cent (Sahli). The cardiac murmur was very faint. Headache and vomiting became a daily occurrence. On one occasion the attack lasted two days, and the patient lost sphincteric control and consciousness. On his admission to the hospital it was noted that he was weak and had an unsteady gait. Neurologic examination showed nothing abnormal except dilated retinal veins. No edema or atrophy of the disks was seen. Arteriographic studies, made at this time (R. J.), consisted of exposure of the vessels of the neck on the left side and injection of 5 cc.

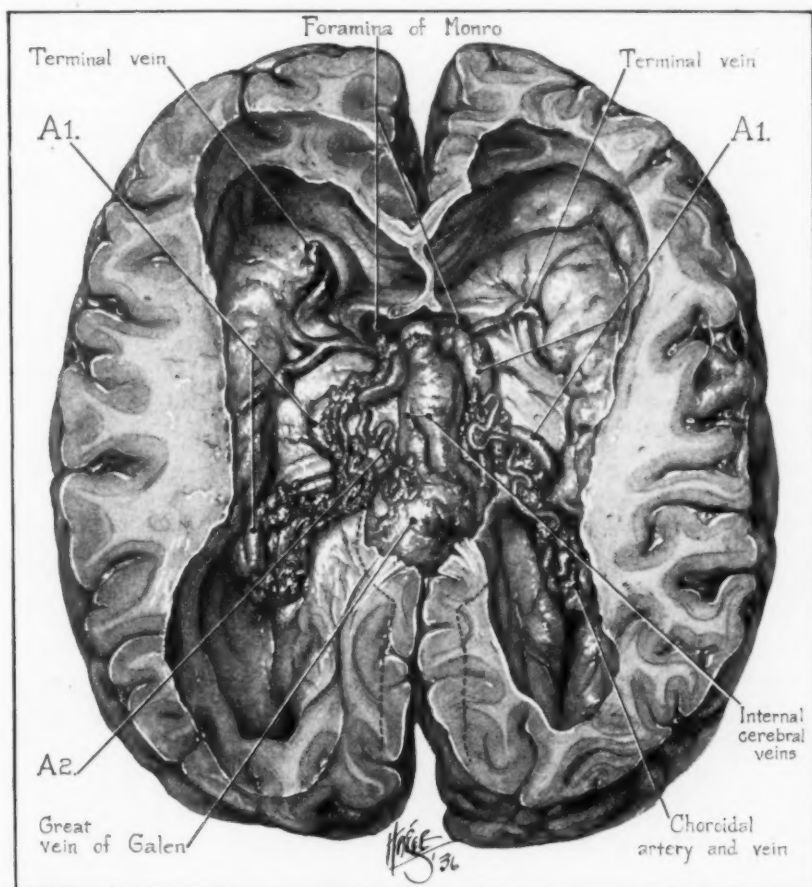


Fig. 3.—Horizontal section of the hydrocephalic brain, to be compared with the diagram of this view (fig. 5). The terminal veins do not enter the internal cerebral veins at the foramen of Monro, as normally, but pass directly into the tremendous sac representing the great vein of Galen. Bilateral anomalous vessels, *A1*, arise from the posterior cerebral arteries and empty directly into the dilated internal cerebral veins at the interventricular foramens. The smaller anomalous vessel, *A2*, has a similar origin but empties into *A1*.

of a 20 per cent solution of sodium iodide into the internal carotid artery. Roentgenograms made after injection showed a very tortuous portion of the carotid artery outside the skull and filling of about 1 inch (2.5 cm.) of the intracranial portion. None of the cerebral arteries was sufficiently filled to be visible, and

no communication between the carotid artery and the venous sinus or the jugular vein was apparent. Both the carotid artery and the jugular vein were large, and the jugular vein ballooned out with only slight pressure. Other procedures, such as ligation of the common carotid artery and ventriculographic studies, were considered, but the patient was discharged in two weeks, to return later.

He was readmitted after two months, with the following history: "Since his discharge the patient's condition has progressively been down hill. He is no longer able to walk or to get up if on his back. He even has difficulty in holding his head up. His speech has become unintelligible and his voice weak. Spells of vomiting occur once a week and last one day. An alternating squint has developed. Intelligence is unimpaired. The spinal fluid pressure is 200 mm." At this time it was our definite impression that the patient had a cerebral arteriovenous communication, most likely on the left side. With this in mind, it was thought best to ligate the left common carotid artery. With anesthesia induced with solution of tribromoethanol U. S. P. and ether, the left common carotid artery was ligated. The postoperative condition was good. He was discharged "unimproved" in three weeks.

The patient's eighth, and last, admission to the hospital occurred only three weeks later. An infection of the respiratory tract was accompanied with high fever, otitis and swelling in the region of the right parotid gland, and he was in extreme pain. Examination of the blood showed 85 per cent hemoglobin (Dare), 4,760,000 red cells and 27,000 white cells, with 82 per cent polymorphonuclear leukocytes. The pupils were dilated; there were mild convulsive movements, stupor and increase in temperature to 105.6 F. He died fifteen hours after admission.

*Necropsy.*—The carotid arteries and the jugular veins were about twice their normal size. The carotid arteries were tortuous, and the left one almost looped on itself. All the veins in the dura and those of the cortex were greatly enlarged. The left jugular vein was three or four times its normal size. The entire ventricular system, from the aqueduct up, was dilated. This condition was caused by the huge, distended great vein of Galen pressing on the aqueduct. This vein was 2 inches (5 cm.) long and 1 inch (2.5 cm.) in diameter. There were a number of anomalous vessels of small size in the vascular arrangement, but the important anomaly consisted in the giving off of large branches from both posterior cerebral arteries to communicate by way of large vessels directly with the small veins of Galen (figs. 2, 3, 4 and 5).

#### COMMENT

Arteriovenous communications are found in all parts of the body but are "most frequently met with about the head" according to Cushing and Bailey.<sup>5</sup> The general mechanical arrangement is the same in all, differing only as to the particular anatomic part in which they occur. These communications are generally classified according to cause as acquired and congenital. Personally, we believe it much clearer to classify them as traumatic, inflammatory and congenital lesions.

5. Cushing, H., and Bailey, P.: *Tumors Arising from the Blood Vessels of the Brain: Angiomatous Malformations and Hemangioblastomas*, Springfield, Ill., Charles C Thomas, Publisher, 1928, p. 35.

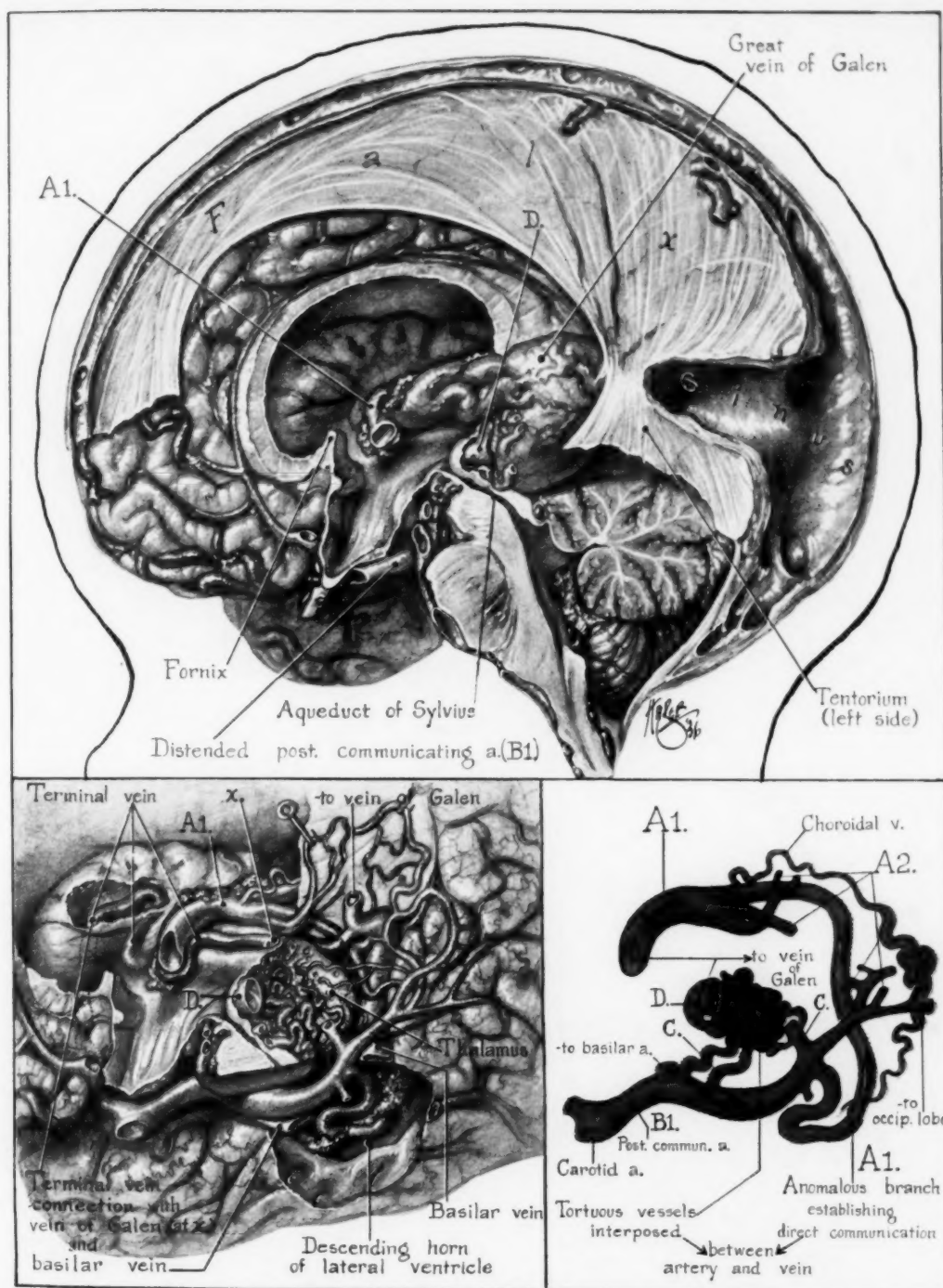


Fig. 4.—Sagittal section of brain, showing the dilated great vein of Galen producing an intermittent block of the aqueduct. The venous sinuses are tremendously enlarged; the torcular Herophili measures 3.5 cm. in width and the left transverse sinus about 2 cm. As seen in a dissection of this view (lower left) and a simplified diagram (lower right), a dilated vessel, *D*, which empties into the great vein of Galen, drains a coil of vessels excavating the posterior portion of the brain stem and the thalamus. This "angioma" is fed by branches (*C*) of the posterior cerebral artery. Direct communication between artery and vein is effected by the anomalous branch, *A1*, whose proximal end has the origin and course of the normal posterior choroidal artery (arising from the posterior cerebral artery); its upper (distal) end represents the choroidal vein terminating in the internal cerebral vein (Galen). Note that the smaller vessels, *A2*, are also direct arteriovenous connections.



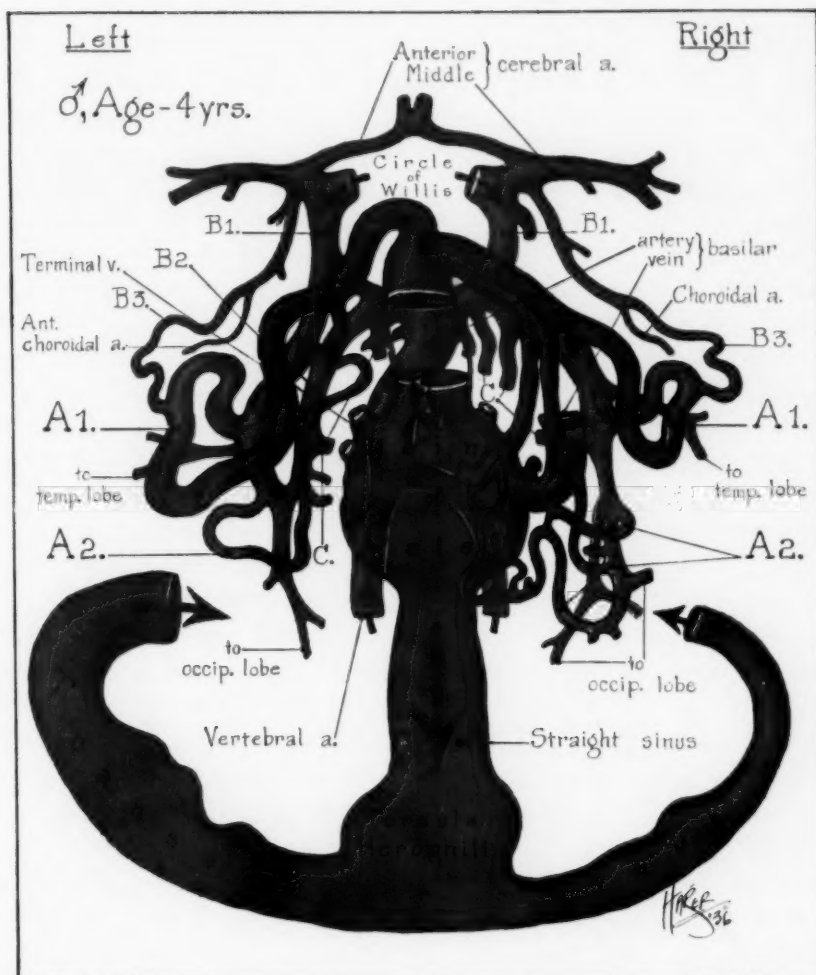


Fig. 5.—Essential features of the direct arteriovenous connections. The coil of vessels interposed between the artery and the vein in the posterior part of the thalamus and brain stem (fig. 4) is not included in this diagram, but the arteries feeding it are shown (C). A1 is the bilateral anomalous branch arising in the position of the posterior choroidal artery from the posterior cerebral artery, which is a direct continuation of the dilated posterior communicating artery, B1. Smaller anomalous vessels, A2, pass through the choroid plexus of the lateral ventricle, as do the vessels A1, which empty into the divided sac representing the internal cerebral veins. Persistence of embryonic features is illustrated by the plexiform or duplicated condition of the left posterior cerebral artery, B2, and by the anastomotic branch, B3, which arises in the position of and gives off the anterior choroidal artery. Anastomosis between the anterior and the posterior choroidal artery is a characteristic of embryonic life which is usually retained to a greater or lesser extent in the adult.



Traumatic communications are common in cases in which large veins and arteries lie in close apposition and when both are injured by a tearing or cutting object, such as a knife or bullet, and in cases of fracture at the base of the skull in which the internal carotid artery may be torn so as to empty its blood directly into the cavernous sinus.

Inflammatory disease may erode the wall of an artery and that of a vein nearby, causing a direct flow of arterial blood into the vein. Such erosion is a common lesion of the internal carotid artery as it passes through the cavernous sinus. Here it is necessary only for the arterial wall to be eroded as a result of arteriosclerosis or other condition and to rupture into the venous pool surrounding it. The infectious type of aneurysm is frequently referred to as mycotic, being caused by circulating micro-organisms lodging in the wall of a vessel.

A third, and quite common, cause of abnormal arteriovenous connections is a failure in the development of the capillary bed which normally is interposed between the arterial and the venous system. As might be expected, this last type of arteriovenous communication usually differs from the first two in having many large anastomosing channels between the arterial tree and the venous return. It is this characteristic when found that identifies it as congenital. Several openings between the artery and the vein are sometimes seen in traumatic and inflammatory communications, but never in such numbers as in the congenital type.

The present case typifies the usual multiple end-on connections between arteries and veins found with congenital arteriovenous aneurysms and, furthermore, adds evidence in support of the commonly held opinion that they are unquestionably congenital, in that in this case they were found bilaterally in the cerebral hemispheres, arising from both halves of the arterial trees of the circle of Willis. Strange to say, as nearly as could be determined by gross dissection, the abnormal anastomoses were largely on the branches of the posterior cerebral artery and its venous return, although anomalous arterial communications were seen to come off the internal carotid artery at the site of the anterior choroidal artery. No communications were found to come from the anterior cerebral artery.

Another interesting feature of the specimen, in addition to the direct arteriovenous communication through large branches, was the overdevelopment of tiny vascular loops into nests of coiled vessels, which undoubtedly represent anomalous attempts to form a capillary bed between artery and vein. This was particularly evident where the posterior cerebral artery gave off branches to a coil of anomalous vessels which lay on the corpora quadrigemina and the thalamus.

Here was an attempt at overformation of many small vessels as a substitute for the formation of a capillary bed.

On comparing the general anomalous vascular arrangement found in this brain with the observations made by Streeter<sup>6</sup> on the development of the venous system of the brain and with those of Padget<sup>7</sup> on the arterial system, one can see distinctly in this specimen the general outline of the vascular pattern found in the human embryo. During the very early stages of fetal development of the circulatory system of the cranial cavity the vascular apparatus is represented by an irregular system of channels which in no way represents the permanent arteries, veins and capillaries. From the walls of these primordial vessels sprout endothelial buds which connect with the already established channels, to form arteries, veins and capillaries which gradually take adult form, even long before these vessels have acquired their fully developed histologic structures. Midway between the stage of vascular pools without movement of fluid through a definite tubular system and that in which a complete circulatory apparatus of arteries with returning veins is established is a stage which corresponds closely with the pattern found in this specimen. One is tempted to conclude that the whole vascular deformity is due to the lack of resistance of a capillary network between arteries and veins, but as yet there is insufficient evidence on which to base any conclusive hypothesis as to what actually determines the malformation. Of interest, however, are the detailed observations of Sharrer<sup>8</sup> that in the Placentalia, as exemplified by the monkey, the cerebral veins lie deep to the cerebral arteries. This makes it necessary for the veins to cross the arteries at right angles in their course to the dural veins. Veins thus are in very close crossed approximation to the arteries. The same vascular arrangement is well known in the human embryo. Padget in her studies<sup>9</sup> on the embryonic development of the cerebral arteries and veins has noted in some sections a definite denting of the vein by the artery where the artery crosses the vein at a right angle. Since the two vessels are separated only by two thin layers of their endothelial walls, the erosion of the artery into the vein, with a resulting direct arteriovenous communication, seems quite possible.

6. Streeter, G. L.: The Development Alterations in the Vascular System of the Brain of the Human Embryo, *Contrib. Embryol.* **8**:5-38, 1918.

7. Padget, D. H., in Dandy, W. E.: *Intracranial Arterial Aneurysms*, Ithaca, N. Y., Comstock Publishing Co., Inc. 1944, p. 70; *Contrib. Embryol.*, to be published.

8. Sharrer, E.: Arteries and Veins in the Mammalian Brain, *Anat. Rec.* **78**: 173, 1940.

9. Padget, D. H.: Personal communication to the authors.

SUMMARY

In this paper is reported a case of bilateral arteriovenous communications of the posterior and middle cerebral arteries observed from birth to the patient's death, at  $4\frac{1}{2}$  years of age, with complete necropsy. The early symptoms were those of repeated nosebleed. Other interesting features of the case were the dilatation and elongation of the veins and arteries with enlargement of the heart. Ligation of the left common carotid artery failed to alter the course of the disease, and the patient succumbed to a convulsion several weeks later.

It is hoped that the present case report will throw some light on the nature of this lesion and will create an interest in its future detection, so that methods may be devised for its successful treatment.

Jefferson Medical College Hospital (7).

## ARTERIOGRAPHIC VISUALIZATION OF CEREBRO-VASCULAR LESIONS

SIDNEY R. GOVONS, M.D.\*

AND

FRANCIS C. GRANT, M.D.

PHILADELPHIA

CEREBRAL angiography as a method of localizing intracranial lesions was first introduced by Egas Moniz in 1927.<sup>1</sup> After injection of radiopaque substance into the carotid artery, roentgenograms of the cerebrovascular tree were taken. Lesions could be identified by their vascular pattern or by the displacement of the cerebral blood vessels. Although Egas Moniz strongly advocated the use of his method for the localization of cerebral neoplasms, for the present air insufflation remains the procedure of choice. There is agreement, however, that cerebral angiography is a useful technic for the localization of certain vascular lesions,<sup>2</sup> namely, intracranial aneurysm, angiomatous malformations, occlusion of the internal carotid artery and traumatic arteriovenous aneurysm. The usefulness of the technic will depend on the proper selection of patients. The case histories presented in this report illustrate the use of cerebral arteriography as an aid in neurologic diagnosis.

### TECHNIC

The technic used was essentially that described by Egas Moniz<sup>3</sup> (1931). After preliminary morphine medication and local procaine anesthesia, a small collar incision was made in the neck and the common or the internal carotid artery exposed. After tape was placed about the vessel, 10 to 15 cc. of a colloid suspension of thorium dioxide was rapidly injected through a 17 or 18 gage needle into the unoccluded vessel. The first roentgenographic exposure to visualize the arteries was made when 10 cc. had entered the circulation. A second exposure, five seconds later, visualized the venous return. Leaking from the artery was easily controlled by pressure after removal of the needle. In rare instances a silk suture through the adventitial coat was necessary. In our experience, post-

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\* Frances Clark fellow in neurosurgery.

From the Department of Neurosurgery, Hospital of the University of Pennsylvania.

1. Egas Moniz: *L'encéphalographie artérielle, son importance dans la localisation des tumeurs cérébrales*, Rev. neurol. **2**:72, 1927.

2. Elvidge, A. R.: *The Cerebral Vessels Studied by Angiography*, A. Research Nerv. & Ment. Dis., Proc. **18**:110, 1938. Gross, S. W.: *Cerebral Arteriography*, Arch. Neurol. & Psychiat. **46**:704 (Oct.) 1941.

3. Egas Moniz: *Diagnostic des tumeurs cérébrales et épreuve de l'encéphalographie artérielle*, Paris, Masson & Cie, 1931.

operative hemorrhage was never a complication. No undesirable reactions were observed after the injection of the thorium dioxide, even though some of the patients were above 60 years of age. The patients were allowed to sit up after returning to the ward and were ambulatory the following morning. Aside from some aching in the throat on swallowing, they experienced little discomfort. Moniz frequently performed this procedure on outpatients, but for the present we have insisted on hospitalization.

#### THE NORMAL ARTERIOGRAM

Although many variations exist in the distribution of the cerebral vessels, the general pattern is more or less similar. The following brief description of the gross features of the normal arteriogram (fig. 1) is based on the studies of Moniz.<sup>3</sup>

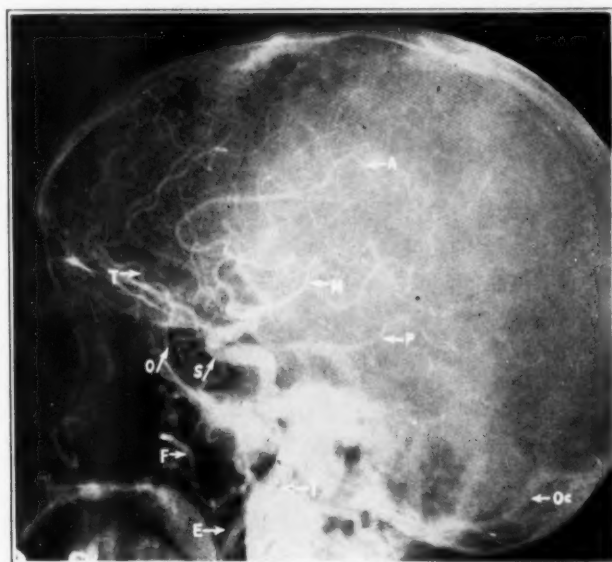


Fig. 1.—The normal arteriogram. *E* indicates external carotid artery; *I*, internal carotid artery; *S*, carotid siphon; *P*, posterior communicating artery, continuing as the posterior cerebral artery; *M*, middle cerebral artery; *A*, anterior cerebral artery; *O*, ophthalmic artery; *T*, superficial temporal artery; *F*, transverse facial artery, and *Oc*, occipital artery.

The internal carotid artery enters the skull through the carotid canal. Coursing ventrally, it passes through the foramen lacerum to enter the cavernous sinus. In its course through the cavernous sinus, it describes first a forward and then a backward curve. These two together have been termed the carotid siphon. On emerging from the sinus, the artery frequently curves forward again to form an S (fig. 2), or double carotid siphon. A double siphon, more or less complete, occurs in 69 per cent of cases. Just before emerging from the cavernous sinus the internal carotid artery gives off the ophthalmic branch.

The posterior communicating artery can often be seen branching posteriorly from the terminal end of the internal carotid artery and in 15 per cent of cases continues backward as the posterior cerebral artery. Often, as in figure 1, the caliber of the posterior communicating vessel is larger than that of the posterior cerebral artery. This substantiates the belief that the posterior cerebral artery, from a developmental viewpoint, should be considered a branch of the internal carotid artery.

Of the terminal branches, the middle cerebral vessels are almost always visualized in the normal arteriogram. They are frequently displaced upward or downward by mass lesions, and their position is, therefore, of importance in localization of tumors. The anterior cerebral vessels, which course medially and anteriorly and then turn backward to outline the curve of the corpus callosum, are less frequently visualized.

Although it would seem preferable to make injections into the internal carotid artery and eliminate the branches of the external carotid artery, the visualization of both circulations yields more information. The thorium dioxide-blood mixture passes more readily into the cerebral circulation than into the branches of the external carotid artery,<sup>3</sup> so that failure to visualize the former when the external circulation is filled directs attention to an occluded internal carotid artery. Not infrequently, as Egas Moniz<sup>4</sup> and Sorgo<sup>5</sup> have demonstrated, the mouth of the internal carotid artery is obstructed in the cervical region, and this lesion could easily be overlooked if the injection were made above the point of obstruction. Furthermore, with a little experience, the branches of the two circulations can readily be distinguished. We have therefore preferred to make the injection into the common carotid artery.

#### INTRACRANIAL ANEURYSM

The incidence of intracranial aneurysm ranges from 0.5 to 1.6 per cent of routine postmortem examinations of the head.<sup>6</sup> Etiologically, these lesions may be classified as mycotic, arteriosclerotic and congenital.<sup>7</sup> The mycotic aneurysm, associated with an infected embolus, is apparently rare and was not encountered in the series reported by Globus and Schwab<sup>6a</sup> and by Richardson and Hyland.<sup>7</sup> Arteriosclerotic

4. Egas Moniz; Lima, A., and de Lacerda, R.: *Hémiplégies par thrombose de la carotide interne*, Presse méd. **45**:977, 1937.

5. Sorgo, W.: *Ueber den durch Gefässprozesse bedingten Verschluss der Art. carotis interna*, Zentralbl. f. Neurochir. **4**:161, 1939.

6. (a) Globus, J. H., and Schwab, J. M.: *Intracranial Aneurysms*, J. Mt. Sinai Hosp. **8**:547, 1942. (b) Wilson, G.; Rupp, C., and Bartle, H., Jr.: *Ruptured Aneurysms of the Circle of Willis*, Tr. Am. Neurol. A. **68**:140, 1942.

7. Richardson, J. C., and Hyland, H. H.: *Intracranial Aneurysms*, Medicine **20**:1, 1941.

aneurysm, though more frequent, is relatively uncommon. Recent investigators attribute most intracranial aneurysms, variously termed miliary, berry or saccular, to congenital lesions.<sup>8</sup> It is generally agreed that syphilis plays little or no role in the formation of intracranial aneurysms. The majority occur in the anterior portion of the circle of Willis; 48 per cent involve the internal carotid or the middle cerebral vessel, and 15 per cent, the anterior communicating branch. Fifty-four per cent occur in patients over 40 years of age and 35 per cent in patients from 21 to 40<sup>9</sup> years of age.

Intracranial aneurysm frequently manifests itself by a subarachoid hemorrhage, with sudden headache, stiffness of the neck and severe pain over the eye or the forehead, with or without loss of consciousness. Frequently, there is paralysis of the extraocular muscles, especially those innervated by the third nerve. Hyperesthesia in the distribution of the ophthalmic division of the fifth nerve with some diminution in the sensitivity of the corneal reflex may be present. Other neighboring nerves may be involved. When the hemorrhage extends into the cerebral hemisphere, contralateral hemiparesis, with or without sensory loss or aphasia, occurs. Papilledema is rare even when greatly increased intracranial pressure exists, although retinal hemorrhages or unilateral loss of vision may occur.

In the following illustrative cases the lesion was visualized by cerebral arteriography.

CASE 1.—A white woman aged 20 years first complained of left frontal headaches in August, 1940 and shortly thereafter noticed drooping of the left upper lid. On November 10 she suddenly became unconscious. On recovery she was unable to speak, the right extremities were paralyzed and the neck was stiff. Lumbar puncture, performed at another hospital, showed grossly bloody fluid. She slowly regained ability to speak, and the right hemiplegia improved.

Examination at the hospital of the University of Pennsylvania on November 30 showed complete ptosis of the left eyelid, with dilatation and fixation of the pupil. The eyeball was drawn downward and outward. There was no measurable choking of the disk, although the margins appeared hyperemic and blurred. Vision, including the peripheral fields, was normal. There was right hemiparesis with dysarthria, scanning speech and some difficulty in naming objects. The blood pressure was 118 systolic and 96 diastolic. Roentgenograms of the skull showed no abnormalities. An arteriogram of the left side of the brain showed a small berry aneurysm of the internal carotid artery (fig. 2).

*Comment.*—This case illustrates the typical history of aneurysm of the internal carotid artery, with left frontal headache and paresis of the third nerve at the onset, followed by subarachoid and intracerebral hemorrhage. In the arteriogram (fig. 2) the aneurysm appears as a

8. Globus and Schwab.<sup>6a</sup> Wilson and others.<sup>6b</sup> Richardson and Hyland.<sup>7</sup>

9. McDonald, C. A., and Korb, M.: Intracranial Aneurysms, Arch. Neurol. & Psychiat. 42:298 (Aug.) 1939.

saccular pouch on the posterior surface of the internal carotid artery immediately after its exit from the cavernous sinus. The neck of the aneurysm seems constricted, while the caliber of the mass is larger than any of the adjacent vessels. According to present concepts, the etiologic factor is a congenital weakness of the wall of the vessel.

CASE 2.—A white woman aged 46 was admitted to the Hospital of the University of Pennsylvania on Aug. 24, 1942. Two months before admission she experienced sudden, severe headache and lost consciousness for forty-eight hours. On awakening from the stupor, she was clear and oriented but could not open the right eye. At the age of 26 she had had a similar attack, suddenly collapsing on the street with severe headache and inability to see. At that time the headache persisted for about a week. Her recovery was uneventful and without neurologic sequelae.



Fig. 2 (case 1).—Aneurysm of the internal carotid artery. Note the double carotid siphon.

Neurologic examination showed complete palsy of the third nerve on the right side. The right eyelid was ptosed, the pupil dilated and fixed to light and in convergence and the eyeball drawn downward and outward. The disk in the right eye was obscured by a retinal fold, which seemed pushed forward by a large subhyaloid hemorrhage. Several other large retinal hemorrhages were present. Other fundal details were obscured. In the left eye the disk was normal, the arteries were somewhat attenuated and were irregular, with increased light reflexes and some arteriovenous compression. Several large superficial and deep hemorrhages were present throughout the posterior part of the retina. Visual acuity was 6/9 in the right eye and 6/22 in the left eye. The peripheral fields were full. The remainder of the neurologic examination revealed nothing abnormal.

The blood pressure ranged from 127 systolic and 90 diastolic to 160 systolic and 110 diastolic. The medical consultant expressed the opinion that the patient probably had slight hypertensive heart disease. The cerebrospinal fluid pressure

measured 270 mm. of water. The fluid was clear and contained 20 red blood cells and 15 white blood cells per cubic millimeter. The protein content was 35 mg. per hundred cubic centimeters. Serologic tests of the spinal fluid and blood gave negative reactions. Roentgenograms of the skull showed blurring and lack of sharp delineation of the sphenoid ridge on the right side. Otherwise the bones of the calvarium appeared normal. There was no evidence of increased intracranial pressure. The sella turcica was within the limits of normal size. An arteriogram of the right side of the brain showed an intracranial aneurysm, probably of the terminal portion of the internal carotid artery (fig. 3).

*Comment.*—In this patient, loss of consciousness with palsy of the third nerve followed a mild subarachnoid hemorrhage. Although the aneurysm was well outlined, the neighboring cerebral vessels were not clearly shown, making localization difficult. The aneurysm appeared to be in the neighborhood of the bifurcation of the internal carotid

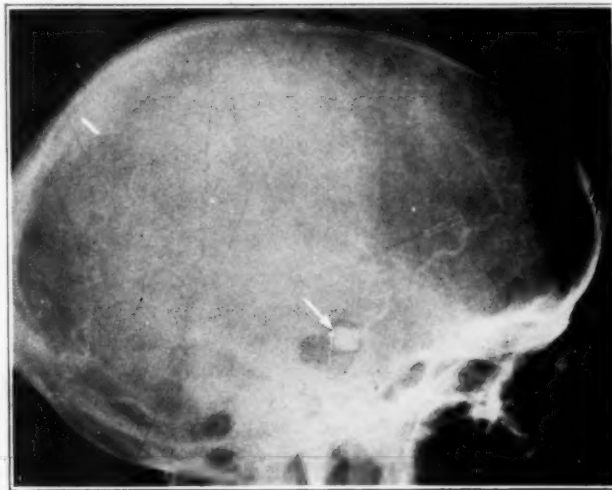


Fig. 3 (case 2).—Aneurysm, probably at the distal end of the internal carotid artery or the beginning of the anterior cerebral artery.

artery, probably along the proximal portion of the anterior cerebral artery. The history of severe headache with unconsciousness twenty years previously seems to support the congenital theory of the origin of the lesion and suggests that intracranial aneurysm may remain quiescent for a long interval.

CASE 3.—A Negro aged 48 had complained intermittently of pain over the left eye with left frontal headaches for a year. Vision in the left eye had gradually become blurred. Three days prior to admission he had noted double vision with inability to open the left eye.

Neurologic examination on the day of his admission to the Hospital of the University of Pennsylvania, July 13, 1942, showed complete ptosis of the left upper lid. The left pupil was dilated and fixed and did not react to light or in convergence. The left eye was turned outward, and external rotation was the

only movement present. The fundus was normal. The left side of the forehead was hyperalgesic. The spinal fluid was bloody and contained 17,600 red blood cells and 28 white blood cells per cubic millimeter. The pressure measured 220 mm. of water. The serologic reactions both of the blood and of the spinal fluid were positive. Roentgenograms of the skull were normal. An arteriogram of the left side of the brain showed an aneurysm of the internal carotid artery (fig. 4).

*Comment.*—Mild subarachnoid hemorrhage and palsy of the third nerve were the prominent features of this case, although unilateral headache and pain in the eye were premonitory symptoms for a year. The use of arteriography would undoubtedly have given an accurate diagnosis prior to the onset of subarachnoid hemorrhage. The location of the aneurysm on the posterior aspect of the carotid siphon shortly after the artery emerges from the cavernous sinus resembles that in case 1

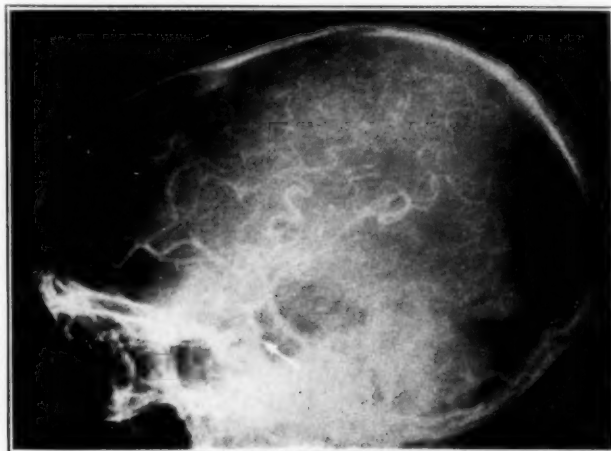


Fig. 4 (case 3).—Aneurysm of the internal carotid artery.

and, again, suggests a congenital origin. Syphilis was probably an incidental discovery and had no relation to the aneurysm.

**CASE 4.**—A white woman aged 69 complained of persistent left-sided headaches for five months. Intermittent paroxysms of severe pain, confined to the upper two divisions of the left trigeminal nerve, occurred. Sometimes the pain radiated into the lower jaw. For the past four years diplopia and some drooping of the left eyelid had been noted.

Examination on May 1, 1941 showed that the left eye could not be abducted and that the left palpebral fissure was smaller than the right. The corneal reflex was diminished on the left side, and the left side of the face was hyperpathic. The left optic nerve appeared pale, and there was mild retinal arteriosclerosis. Visual acuity was 20/70 in the right eye and 20/200 in the left eye. The peripheral field was constricted in the left eye. At times a Babinski sign was elicited on the right side. The spinal fluid pressure measured 180 mm. of water; the fluid was clear and contained 25 mg. of protein per hundred cubic centimeters. Roentgenograms of the skull showed slight hyperostosis of the inner table of the

frontal bone, a calcified plaque in the falx cerebri and ballooning of the pituitary fossa. The dorsum sellae turcica was thin, and the left anterior clinoid process could not be visualized. In the basal view, a shadow of increased density on the left of the pituitary fossa was found. The left foramen ovale was larger than the right. An arteriogram of the left side of the brain showed a large parasellar aneurysm of the internal carotid artery (fig. 5).

*Comment.*—This patient presented the syndrome of the cavernous sinus, with paralysis of the left abducens nerve, atrophy of the optic nerve and involvement of the third and fifth cranial nerves. There was, in addition, a Babinski sign on the left side, suggesting damage to the pyramidal tract. The differential diagnosis lay between neoplasm and aneurysm in the region of the cavernous sinus. The arteriogram revealed the nature of the lesion. Moreover, it demonstrated that the

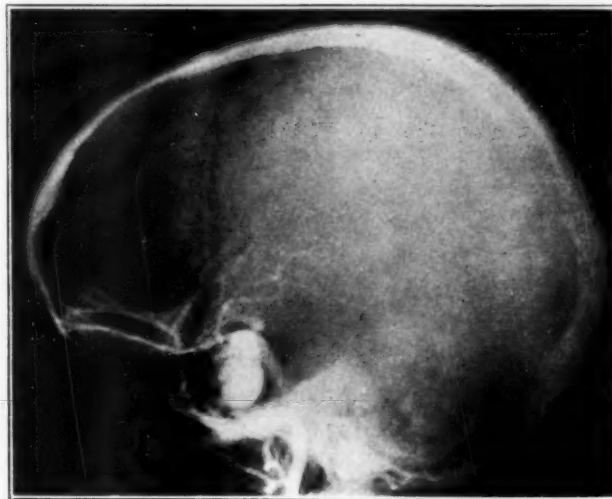


Fig. 5 (case 4).—Large aneurysm of the cavernous portion of the internal carotid artery. Note the loop of the carotid siphon anteriorly.

lesion was not a simple saccular or fusiform aneurysm. Anteriorly, the outline of the carotid siphon was clearly visible, while the posterior portion had been replaced by a blood-containing mass. This suggests that the walls of the artery in this region had become eroded and fused, probably the result of arteriosclerosis.

#### ANGIOMATOUS MALFORMATIONS OF THE BRAIN

Although the term angioma implies neoplasm, this lesion is generally ascribed to a congenital malformation of the cerebral blood vessels. Dandy<sup>10</sup> expressed preference for the term arteriovenous

10. Dandy, W. E.: Arteriovenous Aneurysm of the Brain, *Arch. Surg.* **17**: 190 (Aug.) 1928.

aneurysm. In Cushing and Bailey's <sup>11</sup> (1928) series of verified intracranial tumors the vascular malformations comprised about 1 per cent of the total. Dandy <sup>10</sup> estimated the incidence as 0.5 to 1 per cent of the cases in clinics in which neurologic material is concentrated.

The gross appearance of angiomas is striking. The lesions consist of large, dilated blood vessels with translucent walls, so that the direction of blood flow and the color of the blood are readily recognized. Occasionally, masses of coiled, intertwined arterioles or venules add to the spectacularity of the lesion. Histologically, Cushing and Bailey <sup>11</sup> differentiated these lesions from neoplastic growths by the presence of brain tissue between the cords of vessels. Although they may occur anywhere in the brain, a large proportion occur in the distribution of the middle cerebral artery. Their size is variable, as demonstrated by a comparison of figures 6 and 7 with figure 8.

As a rule, the lesion remains quiescent until adult life; in Dandy's <sup>10</sup> series symptoms appeared after the age of 30 in 44 per cent of the cases. Ray <sup>12</sup> verified the presence of this lesion in a 2½ year old infant. No adequate explanation is available for the delay in the appearance of symptoms. The presenting symptom in about one-half the patients is epileptiform seizures, generalized or jacksonian, with or without loss of consciousness. The seizures may be preceded or followed by transient sensory or motor paralysis. Less frequently the disease manifests itself by an intracranial hemorrhage, with or without paralytic phenomena. In a few patients headache may be a prominent symptom. Usually there is no choking of the disks. Only at times can a head bruit be heard with certainty on auscultation. Roentgenograms of the skull generally show accentuated vascular markings; occasionally intracranial calcification is present. As Northfield <sup>13</sup> pointed out, air studies are of little aid in diagnosis, although there may be a slight displacement of the ventricles or an ill defined filling defect. However, the nature of the lesion is not revealed. The electroencephalogram shows no abnormalities unless injury to the cortex results after hemorrhage, as illustrated in case 7. The diagnosis can be made accurately by use of arteriography, as illustrated in the following cases:

CASE 5.—A white man aged 23 suddenly became extremely dizzy, experienced severe pain over the right side of the forehead and became paralyzed in the left extremities. He recalled that he had noted aching over the right frontal region for several days prior to this accident.

11. Cushing, H., and Bailey, P.: *Tumors Arising from the Blood Vessels of the Brain*, Springfield, Ill., Charles C Thomas, Publisher, 1928.

12. Ray, B. S.: Cerebral Arteriovenous Aneurysms, *Surg., Gynec. & Obst.* **73**:615, 1941.

13. Northfield, D. W. C.: Angiomatous Malformations of the Brain, *Guy's Hosp. Rep.* **90**:149, 1940.

Examination six days later, on May 14, 1941, revealed left spastic hemiplegia with hemianesthesia, moderate stiffness of the neck and an area of paresthesia over the upper two divisions of the right trigeminal nerve. No head bruit was audible; vision, including the peripheral fields, was normal; there was no choking of the disks. The blood pressure measured 120 systolic and 70 diastolic. The cerebrospinal fluid was xanthochromic and contained 238 erythrocytes and 95 monocytes per cubic millimeter. The protein content was 175 mg. per hundred cubic centimeters. The pressure measured 120 mm. of water. Serologic reactions of the blood and of the spinal fluid were negative. Roentgenograms of the skull revealed nothing unusual except for a large venous channel on the right side near the lateral sinus. The electroencephalogram showed no abnormalities. The arteriogram of the right side of the brain (fig. 6) showed a vascular arborization in the right sphenotemporal region, an angiomatous malformation of the brain. The arteriogram of the left side revealed an anomalous distribution of the cerebral arteries but no definite congeries of vessels.



Fig. 6 (case 5).—Angiomatous malformation of the brain in the distribution of the middle cerebral artery.

*Comment.*—This case illustrates an angiomatous malformation of the brain, the presenting symptom of which was subarachnoid and intracerebral hemorrhage. The history was suggestive of intracranial aneurysm. The arteriogram revealed the vascular malformation in the distribution of the middle cerebral artery.

**CASE 6.**—A white man aged 23 complained of epileptiform seizures. For five years the patient had sensations of prickling and numbness, lasting about thirty seconds and occurring three to four times a week. These would start in the right foot and spread upward to involve the entire right side. In June 1940, after one of these sensory attacks, he suddenly became unconscious and had a right-sided convulsion. In the next one and a half years he had seventeen such clonic seizures. Recently clumsiness had been noted in the right hand.

Neurologic examination, on Dec. 1, 1941, showed a normal gait, some impairment of the finer movements of the right hand, normal stereognosis and position sense and some diminution of the protopathic forms of sensation. The tendon

reflexes were slightly more active on the right side than on the left, and the strength of the right arm may have been slightly diminished. There was an old macular choroiditis with partial atrophy of the left optic nerve and weakness of the right side of the face of central type. The cerebrospinal fluid pressure measured 270 mm. of water. The fluid was clear and colorless and contained 50 mg. of protein per hundred cubic centimeters and 6 erythrocytes and 3 monocytes per cubic millimeter. Roentgenograms of the skull revealed a localized calcification in the left middle fossa. The electroencephalogram showed no abnormalities. An air encephalogram showed slight displacement of the midline structures to the right. There was no evidence of hydrocephalus or increased intracranial pressure. An arteriogram of the left side of the brain (fig. 7) showed a large angiomatous malformation, with the internal carotid artery emptying into a large vascular mass deep in the left hemisphere.

*Comment.*—This case illustrates another mode of onset of symptoms of angiomatous malformations of the brain, with jacksonian sensory



Fig. 7 (case 6).—Angiomatous malformation of the brain in the distribution of the middle cerebral artery.

seizures followed by grand mal attacks. The intracranial calcification is characteristic.

**CASE 7.**—A white man aged 42 had been well until two and one-half years before. At that time he had a sudden attack of severe headache and vomiting. Twenty-four hours later numbness and weakness of the left side of the face developed. During a month of hospitalization his symptoms gradually cleared, and on his discharge he felt that he had completely recovered. Three months later he began to have generalized convulsive seizures, characterized by loss of consciousness, frothing at the mouth and urinary or fecal incontinence, followed by drowsiness. These occurred every three to five months but recently had increased in frequency. On Feb. 2, 1943 he suddenly complained of severe headache and vomited frequently. The headache and retching continued for a week, and he was admitted to the Hospital of the University of Pennsylvania.

Neurologic examination showed nuchal rigidity, weakness of the right side of the face of central type and hyperactive tendon reflexes in the right lower extremity. The remaining cranial nerves were normal. The tests for coordination, strength and sensation showed no abnormalities. There were no pathologic reflexes. The cerebrospinal fluid was xanthochromic and contained 2,430 white blood cells and 13,200 red blood cells per cubic millimeter. The pressure measured 580 mm. of water. The serologic reactions were negative. Roentgenographic examination of the skull seemed normal except that the petrous pyramid on the left side was higher and denser than that on the right. The electroencephalogram showed a moderate amount of irregularity, most of which appeared in the left frontotemporal lead. This consisted of slow, irregular waves with a few sharp, focal spikes. The arteriogram of the left side of the brain (fig. 8) showed a small angiomatous malformation in the posterior part of the frontal lobe.

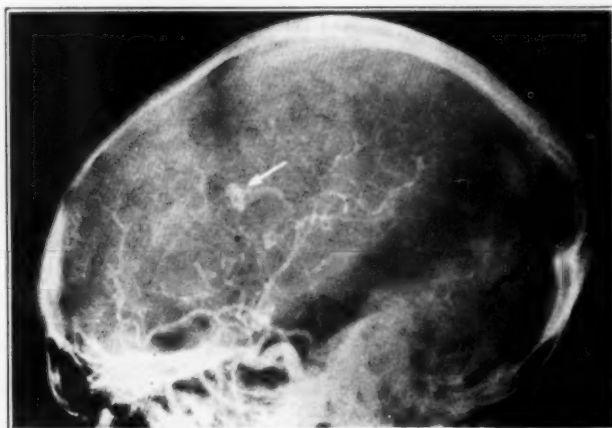


Fig. 8 (case 7).—Small angiomatous malformation in the posterior portion of the frontal lobe.

*Comment.*—As compared with the lesions in cases 5 and 6, this angioma is small. The symptoms of subarachnoid hemorrhage and epilepsy combine the features of the histories in the 2 preceding cases.

#### OCCLUSION OF THE CAROTID ARTERY

Thrombosis of the carotid artery as a source of neurologic disturbance is frequently ignored, both in clinical and in pathologic studies.<sup>14</sup> With the advent of arteriography the demonstration of an occlusion either of the cervical or of the intracranial portion of the internal carotid artery has been made with increasing frequency. In the few instances in which the occluded vessel has been examined histologically the thrombus has been associated with arteriosclerosis.<sup>15</sup>

14. Hunt, R.: The Role of the Carotid Arteries in the Causation of Vascular Lesions of the Brain, *Am. J. M. Sc.* **147**:704, 1914.

15. (a) Galdston, M.; Govons, S.; Wortis, S. B.; Steele, J. M., and Taylor, H. K.: Thrombosis of the Common, Internal and External Carotid Arteries, *Arch. Int. Med.* **67**:1162 (June) 1941. (b) Sorgo.<sup>5</sup>

The disease, however, is by no means confined to the elderly. Sörgo<sup>5</sup> emphasized that young adults are frequently affected. When the common carotid artery is thrombosed, aortic sclerosis or pressure from aortic aneurysm is the most frequent associated lesion. Obliterating syphilitic arteritis without aneurysm; embolism, and nonsyphilitic arteritis have been reported in a few instances.<sup>15a</sup>

Clinical evidence of occlusion to the circulation of the internal carotid artery is varied and probably depends, as Hunt<sup>14</sup> suggested, on the efficacy of the collateral circulation. Symptoms may be absent, and the occluded vessel may be an incidental discovery at autopsy.<sup>16</sup> Epileptiform seizures, syncope, mental aberration, unilateral headache or amblyopia may exist independently and without other neurologic disturbance. A frequent history is that of transient attacks of hemiparesis progressing to permanent hemiplegia with or without sensory paralysis or aphasia. The carotid syndrome of unilateral blindness with contralateral hemiplegia is rarely encountered. Roentgenograms of the skull are usually normal; occasionally calcification of the internal carotid artery may be seen. Encephalograms generally show some dilatation of the homolateral ventricle without shift of the midline structures. The atrophy may be extreme and the entire lobe replaced by a multilocular porencephalic cyst.<sup>17</sup> The arteriographic picture is characteristic; the branches of the external carotid artery are filled; the internal carotid artery can be traced to the point of obstruction, and its cerebral branches are not visualized. If the patent contralateral vessel is injected in the anteroposterior projection, the vessels supplying both hemispheres can be seen.<sup>5</sup>

CASE 8.—A white man aged 24, admitted to the Hospital of the University of Pennsylvania on April 15, 1942, complained of "unconscious spells," which dated back to infancy. Labor was stated to have been prolonged and delivery accomplished with forceps. The left side of the scalp was said to have been severely lacerated. The parents stated that he had not been a "blue baby." During infancy, it was frequently noted that his eyes would roll upward and he would appear to be unconscious for several seconds. These spells increased in frequency and became more noticeable when the patient was about 6 years of age; he frequently bit the tongue and regularly vomited copious amounts of thick, yellow and green vomitus. At the age of 12 it was noted that he usually became stiff and rigid after losing consciousness. The rigidity was followed by a period of amnesia and confusion, often by irritability and even aggressiveness. No clonic convulsive movements occurred. While recovering from the amnesia he often vomited. At first these attacks were very irregular, sometimes occurring every two or three days, sometimes not for a month. On the average, they

16. Darling, S. T., and Clark, H. C.: *Arteritis Syphilitica Obliterans*, J. M. Research **32**:1, 1915.

17. Erb, W.: Ein Fall von ausgedehnter Gehirnerweichung bei totaler Obliteration der Carotis communis sinistra, München. med. Wchnschr. **51**:946, 1904. Galdston and others.<sup>15a</sup>

occurred twice a week. In recent years the frequency of the attacks had diminished considerably, and during the past year he had been free of seizures. In the month preceding hospitalization the seizures returned and he had two attacks similar to those described.

Neurologic examination showed a well developed, slightly asthenic young man, attentive, cooperative and intelligent. Except for slight nystagmus on lateral gaze, the cranial nerves were normal. Examination of the tendon reflexes, sensation, muscular strength and coordination showed no abnormalities. Serologic tests both of the blood and of the cerebrospinal fluid were reported to give negative reactions. The cerebrospinal fluid was clear and colorless and contained no cells. The pressure was normal. Roentgenograms of the skull revealed multiple areas of decalcification localized to the left frontoparietal region. There was no evidence of increased intracranial pressure. The hypophysial fossa was normal in size and shape. An air encephalogram showed moderate dilatation of the lateral ventricles, and the left ventricle was larger than the right. The sub-

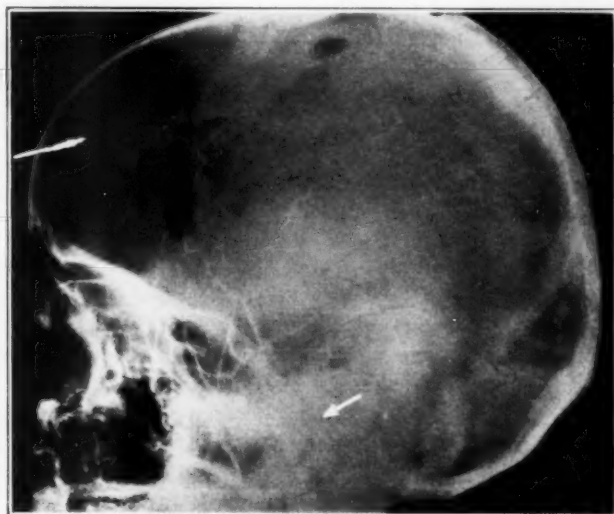


Fig. 9 (case 8).—Occlusion of the internal carotid artery. The cerebral vessels are not visualized. Note the multiple areas of rarefaction of bone confined to the frontal region.

arachnoid channels were all exaggerated. The electroencephalogram showed that the alpha rhythm of  $7\frac{1}{2}$  per second was moderately persistent and equal on the two sides of the head. The general level of activity was normal, but the pattern showed a high degree of irregularity. This irregularity took the form of episodes of large waves with a frequency of 3 to 5 per second which appeared to be coming from the left occipital or suboccipital area, with occasional bursts of similar activity on the right side. Some of the irregular waves had the classic spike and slow wave form, but the greater part of the activity had the appearance of random irregular waves, among which were a number of large, 3 per second forms. The arteriogram of the left side of the brain (fig. 9) showed an occlusion of the left internal carotid artery. The cerebral vessels were not visualized. The branches of the external carotid artery were filled. The arteriogram of the right side of the brain seemed normal in the lateral projection.

*Comment.*—This case illustrates occlusion of the internal carotid artery, which manifested itself by epileptiform seizures dating back to infancy. The unusual presence of multiple areas of rarefaction confined to the frontal area of the affected side is probably related to the birth trauma and is not characteristic of the condition.

CASE 9.—A white man was first hospitalized on Aug. 3, 1938, at the age of 25. He had had severe frontal headaches for two years and thickness of speech for one and a half years. In June 1937 he had the first of a series of seizures, in which he suddenly became dizzy, spun to the left and fell to the floor without loss of consciousness. Neurologic examination showed slurring and thickness of speech, gross tremor of all extremities on voluntary motion, gross tic of the muscles of the shoulder and back and a shaky, distorted handwriting. The cranial nerves were normal. The tendon and superficial reflexes were present, and there were no pathologic reflexes. Roentgenograms of the skull were normal. Serologic and other studies of the spinal fluid showed nothing of significance. An air encephalogram revealed that the internal and external air channels were well visualized. The air channels about the cerebellum, especially near the cerebellar tonsils, were unusually prominent. These observations suggested that the patient had cortical and cerebellar atrophy. He was discharged on Aug. 22, 1938, with the diagnosis of cerebellar ataxia of undetermined causes.

On March 13, 1942, following a bout of severe headache and vomiting, he suddenly became unconscious and was admitted to another hospital. Neurologic examination there showed stupor, Babinski and Kernig signs bilaterally and pronounced nuchal rigidity. The eyes deviated upward and to the right, and there was hypesthesia over both lower extremities and the left side of the abdomen. Lumbar puncture showed grossly bloody cerebrospinal fluid, with a pressure of 225 mm. of water. The patient improved rapidly and when discharged, a week later, seemed to have recovered completely except for a slight memory defect.

On Dec. 1, 1942 he had a similar attack of unconsciousness, and on recovery he complained of a pounding sensation in the frontal area and severe diplopia. He was admitted to the Hospital of the University of Pennsylvania on December 4. Neurologic examination showed paralysis of the right internal rectus muscle with diplopia on gaze to the left. The right pupil was larger than the left, and both reacted promptly to light and in convergence. There were nystagmoid jerkings on gaze to the right. Dysidiadokokinesis, past pointing and rebound phenomena were present in the right extremities. He veered to the right on walking. Plantar stimulation showed a Babinski sign on the left and an equivocal response on the right. He again improved, and by the time of discharge, on December 11, he had only slight weakness of the right internal rectus muscle. The diplopia had cleared. There was only a suggestion of cerebellar dysfunction in the right extremities.

The patient was referred to the neurosurgical department for cerebral angiographic study on December 26. Except for occasional headache, he had no definite complaints. His memory for recent events seemed impaired. He was easily annoyed and irritated by trivial happenings. The right hand grip was weaker than the left; the patient was, however, left handed. Rotary nystagmus could be elicited on gaze to the left. The remainder of the neurologic examination revealed nothing unusual. Examination of the extremities showed interesting signs. There was marked beaking of the finger nails, with clubbing of the distal phalanges. There was a splotchy type of cyanosis over the distal portions of both lower extremities. The right foot was colder than the left. The right

dorsalis pedis artery could not be palpated. The right foot blanched more rapidly than the left on elevation and flushed more slowly in the dependent position. All the toes were cyanotic in the dependent position. The temperature of the skin in response to heat to the forearms did not rise at all, indicating peripheral arterial spasm. The remainder of the medical examination, including roentgenographic study of the chest and electrocardiographic recording, showed no significant deviations from the normal. The arteriogram of the right side of the brain (fig. 10) revealed an occlusion of the right internal carotid artery at the carotid siphon. The arteriogram of the left side of the brain seemed normal, although the cerebral vessels appeared somewhat attenuated.

*Comment.*—This case presented a puzzling neurologic picture clarified by cerebral angiography. The coexistence of peripheral vascular disease and occlusion of the internal carotid artery suggests a cerebral complication of thromboangiitis obliterans, sometimes termed cerebral

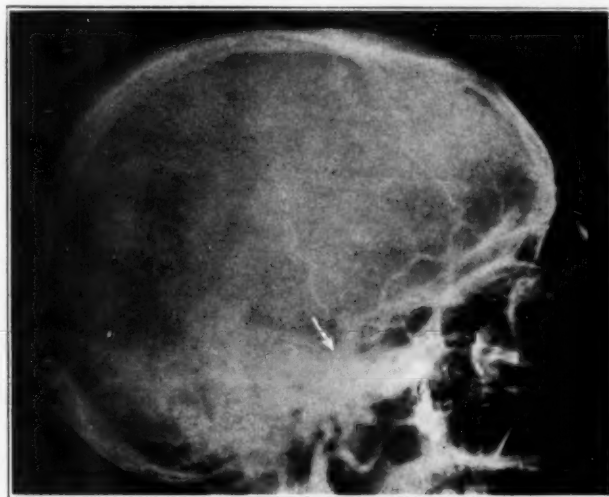


Fig. 10 (case 9).—Occlusion of the internal carotid artery. The cerebral vessels are not visualized.

thromboangiitis obliterans.<sup>18</sup> Hausner and Allen<sup>19</sup> found evidence of cerebral involvement in 2 per cent of the cases of peripheral thromboangiitis obliterans.

CASE 10.—A man aged 60, white, complained of transient attacks during which he was speechless and paralyzed in the right extremities. These started two months prior to his admission; he had ten such seizures, lasting from ten to fifteen minutes. There was no loss of consciousness; he was able to recall conversation and events which occurred during the attack.

18. Davis, L., and Perret, G.: Cerebral Thromboangiitis Obliterans, Quart. Bull., Northwestern Univ. M. School **16**:267, 1942.

19. Hausner, E., and Allen, E. V.: Cerebrovascular Complications in Thromboangiitis Obliterans, Ann. Int. Med. **12**:845, 1938.

Examination on Dec. 30, 1940 showed that the patient was well oriented and intelligent. There was no evidence of aphasia. He walked well, although the right arm did not swing as well as the left. There was diminution of strength in the right extremities. Sensation was normal. The visual fields were full, and the fundi showed mild arteriosclerosis. The blood pressure was 106 systolic and 56 diastolic. The pulse and respiration rates measured 85 and 17, respectively, per minute. Clinical examination of the heart and lungs showed nothing unusual. Light pressure over the right carotid sinus (fig. 11) produced hyperpnea, pronounced drop in blood pressure, slowing of the pulse to about 40 beats per minute, convulsive twitchings of all extremities and syncope. No symptoms were elicited with pressure on the left carotid sinus, although the pulse fell to 60 beats per minute and there was a slight drop in blood pressure. The cerebrospinal fluid pressure was normal. Electrocardiographic studies and roentgenographic examinations of the chest and skull revealed nothing unusual except for suggestive calcification of the cavernous portion of the left internal carotid artery. An arteriogram of the left side of the brain revealed an occlusion of the left internal carotid vessel just proximal to its bifurcation and changes identical with those shown in figures 9 and 10.

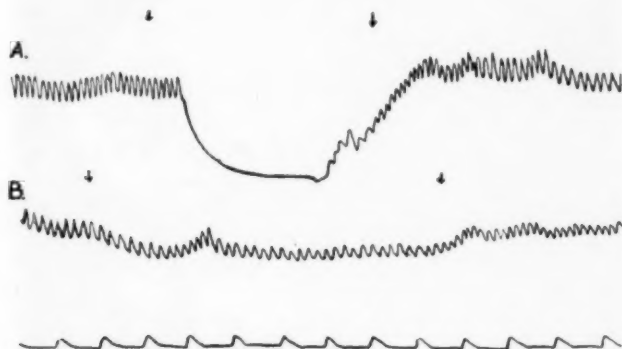


Fig. 11 (case 10).—Unilateral sensitivity of the carotid sinus associated with occlusion of the internal carotid artery. The intra-arterial blood pressure was recorded by means of a needle in the femoral artery. Pressure on the carotid sinus is indicated by the interval between arrows. *A* shows recording during pressure on the right carotid sinus, and *B*, recording during pressure on the left carotid sinus. The lower line represents the timer recording at five second intervals. Syncope and convulsions occurred with pressure on the right carotid sinus. Stimulation of the left carotid sinus, on the side of the occlusion, produced no symptoms.

*Comment.*—The association of thrombosis of the carotid artery and sensitivity of the contralateral carotid sinus has previously been reported, and it suggested the use of arteriography in this case. In the cases reported by Galdston and associates<sup>15a</sup> the occlusion occurred in the common carotid artery, obstructing the carotid sinus region. In case 10 the occlusion occurred in the left carotid siphon, and the carotid sinus region was patent. In both instances, however, pressure on the right carotid sinus produced syncope, convulsions, slow pulse and pronounced drop in blood pressure, while the left carotid sinus was relatively insensi-

tive. The significance of this observation is for the present unknown, although it may have occasional value as a diagnostic sign.

#### TRAUMATIC ARTERIOVENOUS ANEURYSM

The creation of a fistula between the carotid artery and the cavernous sinus is commonly the result of cranial trauma, especially when a basilar fracture of the sphenoid bone occurs. The aneurysm is usually unilateral, rarely bilateral, and the symptoms may progress rapidly or slowly. The most frequent symptoms are bruit, headache and unilateral pulsating exophthalmos, with diplopia, chemosis and visual disturbances.<sup>20</sup> The following case is illustrative of visualization of the lesion by cerebral arteriography.

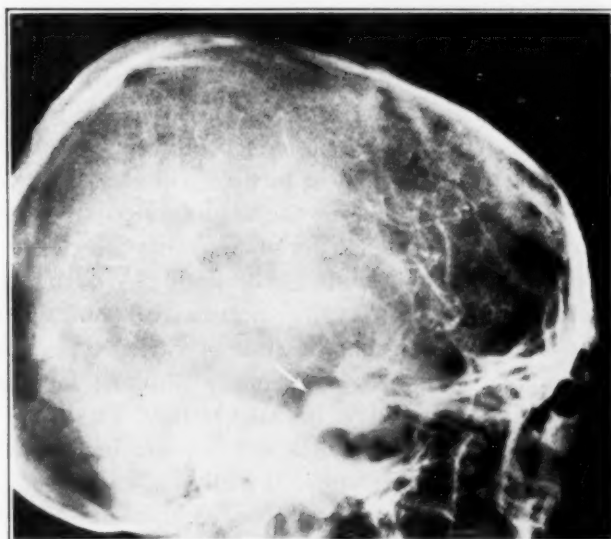


Fig. 12 (case 11).—Arteriovenous communication between the internal carotid artery and the cavernous sinus.

CASE 11.—A white man aged 34 was unconscious for eight hours after an automobile accident, in December 1942. On recovery, he noticed a whirring noise in the head, present constantly and synchronous with the heart beat. On discharge from another hospital, nine days later, he complained of headaches, double vision and spells of dizziness. By the middle of April 1943 both eyes became bloodshot and began to bulge, the right more than the left.

Examination at the Hospital of the University of Pennsylvania, on June 4, 1942, revealed a head bruit, audible all over the head and without localized intensity. Pressure over either common carotid artery stopped the bruit. There was moderately prominent exophthalmos on both sides, more marked on the right. The conjunctiva was injected in both eyes, with slight chemosis on the right.

20. Martin, J. D., and Mabon, R.: Pulsating Exophthalmos, *J. A. M. A.* **121**:330 (Jan. 30) 1943.

The right pupil was smaller than the left and reacted sluggishly to light. The right eye showed limitation in abduction and upward movement. There was some limitation of motion in abduction of the left eye. Diplopia was present in all fields. No pulsation of the eyes could be felt. The right disk was blurred but without measurable elevation. Hemorrhages and exudates were present about the disk and throughout the posterior portion of the fundus. The fundus of the left eye was normal. The vision was 6/9 in each eye, and the fields were full. The remainder of the neurologic examination revealed nothing abnormal. Roentgenograms of the skull showed demineralization of the right half of the dorsum sellae and the right posterior clinoid process. An arteriogram of the right side of the brain (fig. 12) showed an arteriovenous aneurysm of the cavernous sinus.

#### SUMMARY

Cerebral angiography is an important addition to the armamentarium of the neurologist. Intracranial aneurysms, angiomatous malformations of the brain, occlusions of the internal carotid artery and traumatic arteriovenous aneurysms can be accurately localized. If full benefit is to be derived from this technic, accurate knowledge of the clinical course of symptoms which these lesions produce is essential. Careful evaluation of the history and clinical picture will almost always suggest the presence of the lesion shown in the angiogram.

There are, however, several differential points which are associated with these cerebrovascular lesions. Alternating syndromes involving the second, third, fifth and sixth cranial nerves with contralateral pyramidal signs are common. Transient seizures of varied types are frequent. Increased intracranial pressure is generally absent. Unilateral sensitivity of the carotid sinus may be suggestive. Puzzling neurologic pictures in cases in which air studies are not conclusive may at times be clarified by cerebral angiography. Finally, in cases of spontaneous subarachnoid hemorrhage the use of the technic should be seriously considered.

Dr. E. Pendergrass and the staff of the Department of Roentgenology of the Hospital of the University of Pennsylvania gave assistance in making the roentgenographic exposures.

3400 Spruce Street.

## ELECTROENCEPHALOGRAPHIC STUDIES OF PSYCHOPATHIC PERSONALITIES

DONALD J. SIMONS, M.D.  
AND  
OSKAR DIETHELM, M.D.  
NEW YORK

**P**SYCHOPATHIC personalities constitute a large and varied group of personality maladjustments. Patients with such disorders suffer from unsatisfactory functioning of self reliance or adjustment to the group in which they live. In most cases both unsatisfactory self reliance and group adjustment are present. Such personality difficulties cannot be explained by the existence of any of the well defined personality disorders, and at present the psychopathic personality must be considered a separate psychopathologic disorder.

Many attempts have been made to classify and explain the psychopathic personality. Constitutional dynamic factors are considered essential by some psychiatrists. Others believe there is localizable damage to the brain. Inheritance has been found to be a definite factor in many cases. In recent years psychodynamic factors have been stressed. Clinical classifications have been proposed on the basis of various principles. A large group of psychiatrists recognize a relation to the classifiable psychiatric illnesses and diagnose as psychopathic personalities patients who show poorly defined features of psychoses and psychoneuroses (e. g., schizoid, heboid, cyclic, epileptoid, hysterical and compulsive psychopathic states). This kind of classification is obviously one of convenience. Many clinicians stress various types of social difficulties, while only a small number have tried to understand behavior difficulties from a psychopathologic point of view.<sup>1</sup>

In the definition and classification presented in this paper, the whole personality as well as outstanding features and reactions were taken into consideration. It is an accepted fact that any of the aforementioned etiologic factors may have been present but that such an assumption must be proved in the individual case. Psychopathologic reactions must be classified according to fact and reconsidered with new psychiatric orientation.

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This study was supported by the Barbara Henry Research Fund.

From the New York Hospital and the Departments of Medicine (Neurology) and Psychiatry, Cornell University Medical College.

1. Preu, P. W.: The Concept of Psychopathic Personality, in Hunt, J. M.: Personality and the Behavior Disorders, New York, The Ronald Press Co., 1944.

Grouping based on disturbance of function of the personality included disorders of the organization of the personality as well as exaggeration or underdevelopment of personality features. Disorders of the organization of the personality may be due to late maturing (immature psychopathic personality) or to a disturbance of the functions which have to do with the synthesis of the personality (loosely organized psychopathic personality). The immature psychopathic personality shows a psychologic immaturity in comparison with his chronologic age. Such delayed maturing occurs in adolescents as well as in adults and may be observed especially in the attitude toward life and judgment in general. The loosely organized psychopathic personality shows little need and ability for spontaneous adjustment of contradictory strivings and acts. Its opposite type is characterized by lack of plasticity, resulting in rigid personality.

Disturbances of groups of personality functions lead frequently to psychopathic maladjustments. From a practical point of view, personality functions may be subdivided, an artificial and frequently overlapping, but nevertheless useful, procedure. The following subdivisions have been postulated: (1) intellectual resources; (2) emotional tendencies and temperament; (3) volitional and action tendencies; interests and strivings; (4) standards; (5) attitude toward one's own body and toward the instinctive desires; (6) attitude toward material needs; (7) attitude toward oneself and ability to deal with oneself, and (8) social needs and adjustment to the group. In studying psychopathic personalities, one may look for basic disorders in any of these personality functions. In the intellectual field, where, by general consensus, insufficient intellectual development (feeble-mindedness) is excluded, a type of personality characterized by poor concept formation in the setting of an adequate or high general intelligence can be singled out. A large number of patients have difficulties because of insufficient control of excessive emotional reactions. In others, lack of persistence in pursuing goals, vacillation and a discrepancy between ambition and ability are outstanding. Inadequate standards lead to antisocial and asocial acts. Difficulty in controlling instinctive desires is found to be of paramount importance in many sexual perversions. Insufficient self reliance and general inadequacy characterize another type. In many patients there is primarily a disturbance in the attitude and reactions to the group, a lack of belonging and of the need to share with others.

When the many possibilities of psychopathic maladjustment are considered, it becomes obvious that further advances can be made if each patient is studied from a psychobiologic point of view, genetic-dynamic, as well as constitutional, factors being accepted. The mere presence of psychoneurotic reactions does not necessarily explain the whole disorder on a psychoneurotic basis, nor does the presence of

constitutional factors, or a special type of heredity, force one to accept a constitutional cause.<sup>2</sup>

#### COMBINED ELECTROENCEPHALOGRAPHIC AND PSYCHOPATHOLOGIC STUDIES

In the course of routine electroencephalographic examinations of selected patients in the Payne Whitney Psychiatric Clinic, 69 psychopathic personalities were investigated. The electroencephalographic interpretations were made by one of us (D. J. S.) without knowledge of the clinical picture. Records were taken by means of a two channel ink-writing oscillograph of the Grass type, using symmetrically placed bilateral electrodes from the frontal, parietal and occipital regions and the ear lobes. Two minute monopolar and bipolar records were made. Overbreathing was carried out for four minutes. Some of the patients were given 100 Gm. of dextrose by mouth before the test was made in order to eliminate the possibility of slow waves due to low blood sugar. In a few patients the blood sugar level was determined, and the results suggest that probably all the patients had a blood sugar content above 100 mg. per hundred cubic centimeters at the time of the test. (In every case the fasting blood sugar had been determined a few days before the test and was never found to be below 90 mg. per hundred cubic centimeters.) General physical and neurologic examinations were made. All the patients were in good physical health. The psychopathologic study was carried out during a period of one to several months while the patient was in the hospital and consisted of observations on behavior, personality analysis and special psychologic tests. Detailed histories were obtained from patients and relatives and from other sources whenever indicated.

The following psychopathologic patterns emerged:

A. Psychopathic personalities definitely of a psychoneurotic type.

The 12 patients of this type exhibited social maladjustment of such a degree that the diagnosis of psychopathic personality seemed indicated. Some of these patients presented psychoneurotic symptoms, but the total psychopathologic picture was not that of a well defined psychoneurosis. The characteristic feature was an inability to adjust to the realities of life. Any of the previously discussed pathologic personality reactions might be observed. Their recognizable onset was in childhood or early adolescence, and in only a few patients in the latter part of adolescence.

All these patients had normal electroencephalograms.

B. Psychopathic personalities of cyclothymic type.

The outstanding feature in the 7 patients of this type was their pronounced and easily provoked mood swings, which made a successful life impossible. These mood reactions occurred with such frequency as to lead to chronic maladjustment. Many of these patients utilized psychoneurotic factors with these emotional reactions.

All these patients had normal electroencephalograms.

2. Diethelm, O.: Basic Considerations of the Concept of Psychopathic Personality, in Seliger, R. V., and Lindner, R. M.: Handbook of Correctional Medicine, to be published.

C. Psychopathic personalities with poor ethical standards and resulting social difficulties.

Outstanding features were irresponsibility, with disregard of consequences, lack of persistence of emotional relationships and lack of emotional depth.<sup>3</sup> Despite good intelligence, these patients were unable to profit from experience. The symptoms of their maladjustment were stealing, untruthfulness, truancy and irresponsibility with regard to social and financial obligations. All the patients in this group were aggressive.

All 11 patients had abnormal electroencephalograms characterized by 5 to 7 a second, moderately slow activity (fig. 1).

D. Psychopathic personalities with loose organization of personality and immaturity.

The characteristics were unsatisfactory emotional control, contradictory strivings, poor self discipline and, frequently, a rebellious attitude toward authority and society. These patients were of the aggressive as well as of the passive types.

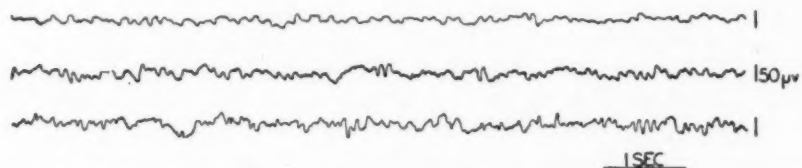


Fig. 1.—Specimens of the right parietal leads of 3 patients. These records exhibit the 5 to 7 a second type of abnormality.

The 31 patients of this type who were studied presented a mixed group of electroencephalographic patterns, in which normal, moderately slow and very slow and fast types of activity occurred.

E. Psychopathic personalities with a generally inadequate type of personality and vague thinking.

These patients lacked persistence in pursuing goals, which were frequently poorly defined. They had a tendency to blame their inadequacies on external situations and on lack of help from others. They expected to be supported by others but had not developed an undue emotional dependence on them. Minor psychoneurotic reactions, with anxiety and resentment as the outstanding emotions, occurred readily. Some of them had high ethical standards; others, unusually low. All were of average or superior intelligence, but they showed difficulty in concept formation and logical thinking. They were of the aggressive as well as of the passive types. There were 8 patients in this group, of whom 5 had low voltage activity slower than 5 to 7 a

3. Greenacre, P.: Conscience in the Psychopath, *Am. J. Orthopsychiat.* **15**: 495-509 (July) 1945.

second and none had an electroencephalogram which was considered normal (fig. 2).

#### ELECTROENCEPHALOGRAPHIC DATA

Records showing frequencies lower than 8 a second or an abundance of waves slower than 8 a second in the frontal leads, regardless of amplitude, were considered abnormal. This is essentially in accordance with the criterion of Gibbs, Gibbs and Lennox.<sup>4</sup> The record of 1 patient was considered abnormal during overbreathing only.

All the abnormal records fell under the type of electroencephalograms usually called "pathologic record of undetermined type." Fifty-three

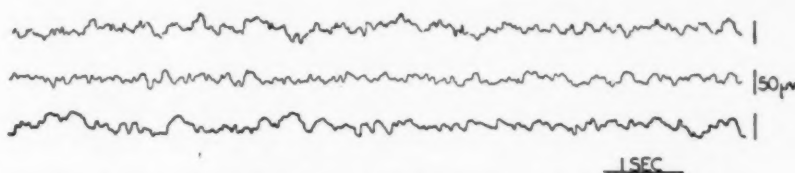


Fig. 2.—Specimens of the right parietal leads of 3 patients. These records exhibit activity which is slower than 5 cycles per second.

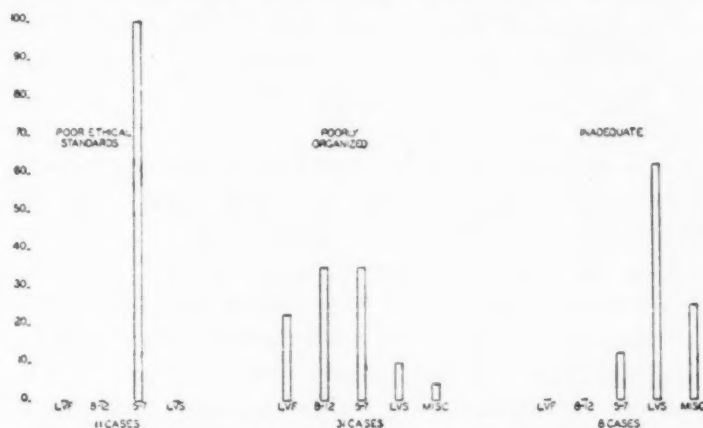


Fig. 3.—Distribution of electroencephalographic abnormalities among the clinical groups.

per cent of the patients had abnormal records. It was possible to divide these pathologic records into two types, namely, those of average amplitude, 5 to 7 a second activity, and those of low voltage, slower than 5 to 7 a second activity. A third pattern—low voltage, fast activity—was frequently encountered, but it was not considered definitely abnormal.

The majority of the abnormal records were those containing sufficient 5 to 7 a second activity of low average amplitude in the frontal

4. Gibbs, F. A.; Gibbs, E. L., and Lennox, W. G.: Electroencephalographic Classification of Epileptic Patients and Control Subjects, *Arch. Neurol. & Psychiat.* 50:111-128 (Aug.) 1943.

and parietal leads to be considered beyond the limits of normal. Some 5 to 7 a second activity is commonly found in the frontal records of normal subjects, but it is unusual in the parietal leads. Any considerable amount of it in the frontal and parietal leads must certainly be considered abnormal. Figure 1 shows samples of records from the parietal leads of 3 patients with the 5 to 7 a second type with low average amplitude.

Figure 2 shows samples of the activity of low average amplitude which was slower than 5 to 7 a second.

Figure 3 shows the distribution of electroencephalographic abnormalities among the clinical groups.

#### COMMENT

Hill and Watterson<sup>5</sup> reported that 65 per cent of their 66 "predominantly aggressive psychopaths" and 32 per cent of 38 "predominantly inadequate psychopaths" (Henderson's<sup>6</sup> classification) had abnormal records, while 5 "purely delinquent" persons and 7 of 8 persons with sexual perversion had normal records. The most characteristic abnormality in the records of these persons was the occurrence of relatively well formed 4 to 6 a second waves of slightly less than average amplitude occurring in bursts of 3 to 6 waves at a time. This is in approximate agreement with our observations.

These authors also looked for isolated, random waves with a frequency of 6 per second or less and a voltage equal to or more than that of the dominant rhythm and for series of waves with frequency of 14 a second or more and a voltage rising to over half that of the dominant rhythms. They did not mention finding such abnormalities.

Their criterion of abnormalities due to overbreathing may be correct, but it is not one which is in general use; namely, "3-cycle smooth waves of high voltage [appearing] either as a continuous series or in bursts of 3-6 at a time [and] their persistence for more than 20 seconds after the cessation of hyperventilation or . . . their re-occurrence after the record has started to return to normal."

Knott and Gottlieb<sup>7</sup> did not differentiate types of psychopathic personality beyond "unspecified [type], [those] with pathologic sexuality, those with pathologic emotionality, [those] with asocial and amoral trends." They considered as abnormal those records showing frequent bursts of rhythmic activity slower than 8 a second and of a voltage

5. Hill, D., and Watterson, D.: *Electro-Encephalographic Studies on Psychopathic Personalities*, *J. Neurol. & Psychiat.* **5**:47-65 (Jan.-April) 1942.

6. Henderson, D. K.: *Psychopathic States*, New York, W. W. Norton & Company, Inc., 1939.

7. Knott, J. R., and Gottlieb, J. S.: *The Electroencephalogram in Psychopathic Personality*, *Psychosom. Med.* **5**:139-141 (April) 1943.

greater than the average voltage of the record, or, if infrequent, protracted bursts of slow activity. They considered as questionably abnormal those records which showed repetitive slow waves of low voltage occurring infrequently in short sequences. They did not make use of records obtained during or after hyperventilation. Fifty-two per cent of their patients had records which were "not normal." It is interesting that so many of their patients with pathologic sexuality had abnormal records (5 out of 7), for other investigators have rarely found electroencephalographic abnormalities among psychopathic personalities with pathologic sexuality.

It is difficult to evaluate pathologic sexual activity because this psychopathologic reaction may occur in different types of psychopathic personalities. In the group of patients we studied, 2 belonged to the type characterized by poor ethical standards (pathologic electroencephalogram) and 4 to the loosely organized, immature type (pathologic electroencephalogram); their electroencephalographic records corresponded to those of the group mentioned and did not offer a uniform pattern which could be related to pathologic sexual life.

In their second paper,<sup>8</sup> in which the Gibbs, Gibbs and Lennox classification was used, Knott and Gottlieb did not distinguish types of psychopathic personality. Of the 68 patients reported on there, 55 per cent had abnormal records. Twenty-six per cent of their patients were in the 16 to 17 year age group, and 47 per cent were under 22 years old. In the present study 36 per cent were in the 30 to 40 year old group.

Silverman<sup>9</sup> classified 75 psychopathic personalities under three types: hostile, hedonistic and inadequate. Electroencephalograms were classified as normal, borderline and abnormal. He designated as abnormal those records which contained frequencies "below 7.5 a second and/or high voltage spike activity in roughly more than 10 per cent of the record." In the borderline group were placed records showing arrhythmia and those showing abnormality only on overbreathing. Of his patients, 20 per cent had normal records; 26.6 per cent had borderline records, and 53.4 per cent had abnormal records. Of the last group, one-half had definite 6 a second activity in the frontal and prefrontal areas. The bulk of his patients were in the 19 to 21 year age group; 45 per cent were between 19 and 24 years of age. In contrast to our series, 53 per cent (39) of his subjects had "neurologic signs and/or histories suggestive of a cerebral lesion." Of these 39 patients 80 per cent had doubtful or abnormal records, and 81 per cent of his 36

8. Knott, J. R., and Gottlieb, J. S.: Electroencephalographic Evaluation of Psychopathic Personality: Correlation with Age, Sex, Family History and Antecedent Illness or Injury, *Arch. Neurol. & Psychiat.* **52**:515-519 (Dec.) 1944.

9. Silverman, D.: Clinical and Electroencephalographic Studies on Criminal Psychopaths, *Arch. Neurol. & Psychiat.* **50**:18-33 (July) 1943.

patients without evidence of disease of the nervous system had doubtful or abnormal records. It is noteworthy that Silverman's "material included examples of the most extreme and dangerous criminal psychopathic types." There is no indication that the psychopathic personalities in his series were essentially different from those in ours. Their extremely asocial behavior does not necessarily indicate a greater degree of psychopathologic malfunction but may be the result of environmental influences.

All patients in the present study were examined from a neurologic point of view, but no defects in function of the nervous system were found. There was no evidence of any structural change in the brains of these patients. Records obtained from persons with brain tumor, neurosyphilis, some cases of encephalitis and multiple sclerosis usually show patterns of higher amplitude and slower rate than any seen in this group. For this reason, also, it cannot be inferred that there were any underlying structural changes in the brains of the persons studied here. The abnormalities must be considered a result of some physiologic anomaly.

#### SUMMARY

From our studies it appears that the concept of psychopathic personality can be more clearly defined than it has been previously. In a considerable number of psychopathic personalities, distinct clinical pictures can be differentiated. Two of the groups with psychopathic personalities had particular types of electroencephalographic abnormalities. Those of a third group were not well defined, showing both normal and pathologic patterns.

525 East Sixty-Eighth Street (21).

## PHENOMENA OF FLUCTUATION, EXTINCTION AND COMPLETION IN VISUAL PERCEPTION

COMMANDER M. B. BENDER, MC(S), U.S.N.R.

AND

PHARMACIST'S MATE THIRD CLASS H. L. TEUBER, U.S.N.R.\*

OF THE various systems which subserve perception in the primate organism, perhaps none has been better explored than the visual apparatus. A good deal of information on the optic pathways has been obtained by the anatomist and the clinician. According to Brouwer and Zeeman,<sup>1</sup> Brouwer<sup>2</sup> and Poliak,<sup>3</sup> the visual fibers originating in the retina follow an orderly path and seem to show throughout a point for point relationship to the occipital cortex. However, from the functional standpoint the concept of point for point representation is not altogether tenable. Recent physiologic and clinical investigations have revealed that a mechanism such as the "peaking of excitation processes" in widely overlapping neurons provides a better hypothesis for visual function.<sup>4</sup> Talbot and Marshall's animal experiments show that this dynamic representation furnishes a closer correspondence between retina and visual cortex than any fiber per fiber relationship could ever yield to the seeing organism.

On the other hand, the mass of clinical material on the extent of impairment following circumscribed lesions in the geniculocalcarine

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\* Formerly in the Department of Psychology, Harvard University.

This article has been released for publication by the Division of Publications of the Bureau of Medicine and Surgery of the United States Navy. The opinions and views set forth in this article are those of the writers and are not to be construed as reflecting the policies of the Navy Department.

1. Brouwer, B., and Zeeman, W. P.: Projection of Retina in Primary Optic Neuron in Monkeys, *Brain* **49**:1-35, 1926.

2. Brouwer, B.: Chiasma, Tractus opticus, Sehstrahlung und Sehrinde, in Bumke, O., and Foerster, O.: *Handbuch der Neurologie*, Berlin, Julius Springer, 1936, vol. 6, pp. 449-532.

3. Poliak, S.: The Main Afferent Fiber Systems of the Cerebral Cortex in Primates, University of California Publications in Anatomy, Berkeley, University of California Press, 1932, vol. 2; A Contribution to the Cerebral Representation of the Retina, *J. Comp. Neurol.* **57**:541-617, 1933.

4. Talbot, S. A., and Marshall, W. H.: Neural Mechanisms of Visual Localization, *Am. J. Ophth.* **24**:1255-1264, 1941. Marshall, W. H., and Talbot, S. A.: Recent Evidence for Neural Mechanisms in Vision Leading to a General Theory of Sensory Acuity, *Biol. Symposia* **7**:117-164, 1942.

pathway suggests that there is indeed a close correspondence between the amount or locus of fibers which are damaged and the localization and extent of resulting scotomas. The closeness of this correspondence has sometimes been questioned with regard to the macular region; but with use of proper procedures so-called macula sparing appears to be either a mere phase in a developing hemianopsia or a sign of readjustment to a defect which actually splits the macular region.<sup>5</sup>

Both for practical and for research purposes, the perimeter and the tangent screen are the instruments of choice in defining the locus, extent and density of any scotoma. A perimetric examination is admittedly time consuming, but no clinician will forego such examination if a neoplasm is suspected or if the extent of a cerebral injury involving the optic pathway has to be defined.

Perimetric measurement thus gives an adequate picture of loss or impairment in anatomic structure. But such a field does not unequivocally define how much a patient actually sees.<sup>6</sup> Subjectively he may see either more or less than his plotted field would show. Objectively, additional changes in visual function might be demonstrated by methods other than perimetric measurement or tangent screen examination.

#### SUBJECTIVE FIELD OF VISION

By the term subjective visual field we mean the vision of which the person is aware and which he describes. One of the major factors that make the field experienced by the patient different from the one plotted on the perimeter is the varying degree of awareness of a scotoma which he may have. A small plotted scotoma may be so apparent and bothersome to a patient that it can become almost an obsession. Conversely, he may be unaware of a large scotoma to such an extent that his attitude may resemble that in the syndrome of denial of blindness, as described by Anton and others.<sup>7</sup> Between these two extremes are various gradations of disturbances of awareness. It is well known that most patients with hemianopsia eventually are unaware of their defect. This has been explained by the fact that the median

5. Bender, M. B., and Kanzer, M. G.: Dynamics of Homonymous Hemianopias and Preservation of Central Vision, *Brain* **62**:404-421, 1939.

6. Compare Fuchs's<sup>8</sup> classic distinction between visual field (*Gesichtsfeld*—perimetric field) and field of actual vision (*Schfeld*—psychologic field).

7. Anton, G.: Ueber Herderkrankungen des Gehirns, welche vom Patienten selbst nicht wahrgenommen werden, *Wien. klin. Wchnschr.* **11**:227-229, 1898. Redlich, F. C., and Dorsey, J. F.: Denial of Blindness by Patients with Cerebral Disease, *Arch. Neurol. & Psychiat.* **53**:407-417 (June) 1945. Bender, M. B., and Furlow, L. T.: Visual Disturbances Produced by Bilateral Lesions of the Occipital Lobes with Central Scotomas, *ibid.* **53**:165-170 (March) 1945.

plane has been shifted and a new center of distinctness, or a "pseudofovea," has been formed.<sup>8</sup>

The various intermediate degrees of partial awareness of scotomas have been less explored and are somewhat unfamiliar to most examiners. Their phenomenology is complicated by the fact that many of the most pronounced displacements and distortions of images occur in defective fields of vision which are in the process of reorganizing themselves around an emerging pseudofovea. Thus, a patient may apportion different parts of a homonymous scotoma to each eye. For instance, he will maintain that one eye is obscured by a "curtain" shorter than one which apparently covers the other eye, even though perimetric examinations show congruent defects in the homonymous fields.

Besides disturbances in awareness, the subjective fields of vision may be characterized by far reaching qualitative changes in perception. Such phenomena as monocular diplopia and polyopia,<sup>9</sup> micropsia or macropsia,<sup>10</sup> dysmorphopsia<sup>11</sup> and disturbances in perception of color<sup>12</sup> and of motion<sup>13</sup> could be found in the defective regions of the fields of vision.

These disturbances in perception are present much more commonly than has hitherto been reported and must be more than pathologic curiosa. Indeed, they seem to reveal certain aspects of the psychologic and physiologic forces which underlie all normal perception, especially for color, space and motion. The patient's verbal reports and drawings of what he sees have therefore considerable heuristic value.

8. Fuchs, W.: Untersuchungen über das Sehen der Hemianopiker und Hemiamblyopiker: I. Verlagerungserscheinungen, *Ztschr. f. Psychol.* **84**:67-169, 1920; II. Die totalisierende Gestaltauffassung, *ibid.* **86**:1-143, 1921.

9. Hoff, H., and Pötzl, O.: Zur diagnostischen Bedeutung der Polyopie bei Tumoren des Occipitalhirnes, *Ztschr. f. d. ges. Neurol. u. Psychiat.* **152**:433-450, 1935.

10. Gelb, A., and Goldstein, K.: Zur Frage der gegenseitigen funktionellen Beziehung der geschädigten Sehphäre bei Hemianopsie (Mikropsie infolge der Vorherrschaft der Vorgänge in der geschädigten Sehphäre), *Psychol. Forsch.* **6**:187-199, 1925.

11. Gelb, A.: Ueber eine eigenartige Sehstörung ("Dysmorphopsie") infolge von Gesichtsfeld einschränkung: Ein Beitrag zu der Lehre von den Beziehungen zwischen "Gesichtsfeld" und "Sehen," *Psychol. Forsch.* **4**:38-63, 1923.

12. Gelb, A.: Ueber den Wegfall der Wahrnehmung von Oberflächenfarben; Beiträge zur Farbenpsychologie auf Grund von Untersuchungen an Fällen mit erworbenen, durch zerebrale Läsionen bedingten Farbensinnstörungen, *Ztschr. f. Psychol.* **84**:193-257, 1920.

13. Goldstein, K., and Gelb, A.: Zur Psychologie des optischen Wahrnehmungs- und Erkennungsvorgangs, *Ztschr. f. d. ges. Neurol. u. Psychiat.* **41**:1-142, 1918.

## OBJECTIVE DEPARTURES FROM THE PERIMETRIC FIELDS OF VISION

Most of the aforementioned subjective disturbances are admittedly elusive. However, they can be systematically explored by special methods of investigation, which are as objective as perimetry and tangent screen studies. Some of the methods which have been employed in the past may be mentioned. 1. The pointing experiment of Poppelreuter,<sup>14</sup> who advocated the use of a "haptic perimeter," and of Best.<sup>15</sup> With this method the patient is required to point manually at a target presented in his field of vision.<sup>16</sup> 2. Bisection of lines, a simple laboratory experiment adapted by Best<sup>15</sup> for the exploration of defective fields. Here the patient is instructed to bisect a line presented in any one meridian while fixing at one end. 3. Prolonged exposure of a given target in the field of vision (Poppelreuter<sup>14</sup>; Goldstein<sup>17</sup>). The subject is asked to fix at a target and report the changes which may occur in the field of vision during a period of fixation. 4. Double stimulation, as described by Wundt and others<sup>18</sup> for the cutaneous senses. The patient is told to fix at a point and describe the appearance of objects exhibited simultaneously on either side of the point of fixation. 5. Tachistoscopia, recommended by numerous authors since World War I (Poppelreuter<sup>14</sup>; Fuchs<sup>8</sup> and Goldstein<sup>17</sup>). Stimuli are exposed at various speeds to the light-adapted or the dark-adapted eye, and the subject describes what he sees. 6. After-imagery, as used originally by Brückner,<sup>19</sup> by Fuchs<sup>8</sup> and, more recently, by Ruesch.<sup>20</sup> The person is instructed to report the after-images he may see after visual stimulation under varied and specified conditions.

14. Poppelreuter, W.: Die psychischen Schädigungen durch Kopfschuss im Kriege 1914-1916: Die Störungen der niederen und höheren Sehleistungen durch Verletzungen des Okzipitalhirns, Leipzig, Leopold Voss, 1917, vol. 1.

15. Best, F.: Hemianopsie und Seelenblindheit bei Hirnverletzungen, *Arch. f. Ophth.* **93**:97, 1917.

16. Goldstein (Constriction of Visual Fields, *Arch. Neurol. & Psychiat.* **50**:486-487 [Oct.] 1943. Goldstein and Gelb<sup>25</sup>), besides stressing the importance of "pointing," introduced a special "string perimeter" which allows for perimetric determinations at various distances from the patient. In this way, the "tubular" (concentric) constriction of visual fields in some cases of organic disease can be demonstrated to vary with the distance of the targets from the patient.

17. Goldstein, K.: After Effects of Brain Injuries in War, New York, Grune & Stratton, Inc., 1942.

18. Wundt, W.: Beiträge zur Theorie der Sinneswahrnehmung, Leipzig, C. F. Winter, 1862, p. 62. Ranschburg, P.: Ueber Hemmung gleichzeitiger Reizwirkungen, *Ztschr. f. Psychol.* **30**:39-86, 1902.

19. Brückner, A.: Zur Frage der Lokalisation des Kontrastes und verwandter Erscheinungen in der Sehsinns substanz, *Ztschr. f. Augenh.* **38**:1-14, 1917.

20. Ruesch, J.: Dark Adaptation, Negative After-Images, Tachistoscopic Examinations and Reaction Time in Head Injuries, *J. Neurosurg.* **1**:243-251, 1944.

Obviously, this list of methods is not all inclusive,<sup>21</sup> but these procedures have been found to be useful in exploring the various principles underlying visual functions in a defective substrate. Such functions will become apparent in the form of objective departures from the perimetric fields of vision. For example, the pointing test or the bisection of lines can reveal systematic errors in relative and absolute localization in the visual space.<sup>22</sup> The amount and direction of errors thus elicited will indicate whether or not the median plane of the field of vision has shifted and a pseudofovea formed. Such a shifting of the median plane may or may not be uncovered by perimetric examination. In cases in which perimetric study fails to reveal this shift while bisection of lines and the pointing test make it manifest, one speaks of an "objective departure" from the perimetric field. This particular departure would demonstrate the principle of functional organization of the field of vision about a center of distinctness regardless of whether or not the corresponding original anatomic substrate is present. The classic observations and deductions on this topic were described during and after World War I. For an excellent review of the entire subject, the reader is referred to the paper by Klüver.<sup>23</sup>

The formation of a new fovea and the associated phenomena relate to the spatial organization of the field of vision. However, there are other functions which involve both spatial and temporal factors in perceptual organization. These functions can be made apparent through such methods as prolonged exposure, double and simultaneous stimulation, tachistoscropy and after-imagery.

21. Other methods are, e. g., the use of visual flicker, as suggested by Klüver's ablation experiments on monkeys (Klüver, H.: *Functional Significance of the Geniculo-Striate System*, Biol. Symposia 7:253-299, 1942) and applied by Riddell (Use of the Flicker Phenomenon in the Investigation of the Field of Vision, Brit. J. Ophth. 20:385-410, 1936) to the exploration of visual fields, and the use of the stroboscope (Werner, H., and Thuma, B. D.: A Deficiency in the Perception of Apparent Motion in Children with Brain Injury, Am. J. Psychol. 55:58-67, 1942).

22. It should be borne in mind that the kinesthetic sense and the motor functions of the extremity used in pointing or bisecting must be intact.

23. Klüver, H.: *Visual Disturbances After Cerebral Lesions*, Psychol. Bull. 24:316-358, 1927. Klüver succinctly stated the conclusions from observations on patients with injuries of the brain in World War I to this effect: Studies on anatomic localization became barren in spite of the wealth of material once the general topography of the "cortical retina" had been established. By contrast, research on higher perceptual functions revealed that these functions were relatively independent of specific structures. For these reasons, Klüver joined such authors as Goldstein and Gelb (footnotes 13 and 17) in stressing the need for continuing both "phenomenologic" and experimental exploration of these perceptive processes in defective visual fields.

## FUNCTIONS INVOLVING TEMPORAL AND SPATIAL FACTORS

The phenomena which we wish to consider in particular are (*a*) fluctuation, (*b*) extinction and (*c*) completion of images. By fluctuation we mean that the visual image in the affected region may fluctuate in distinctness at a varying rate or may disappear and reappear at a certain rate. By extinction we mean that during fixation at a given point the image disappears completely in any part of the field of vision after a certain period. Between extinction and fluctuation of the visual image a continuum of intermediate states may be found. These gradations may be subsumed under the term "obscuration" (dimming) of the image. In certain cases extinction can be demonstrated only under special conditions. Objects exposed in impaired parts of the field may become invisible on simultaneous exhibition of another stimulus in a less impaired or in an intact part.<sup>24</sup> Completion of images should be understood as follows: Images involving both impaired and comparatively unimpaired regions of a field of vision are "completed" under certain conditions. This takes place in spite of the fact that the image is invisible if presented to the impaired region alone. Again, several gradations are possible. Sometimes only partial continuation of figures into the defective region is encountered. Total completion has been reported to occur specifically (*a*) if the test figures possess good contour and are symmetric, simple configurations and (*b*) if the figures are not too large and one half or more of their area is exposed to the intact portion of the field of vision.

Of these three phenomena, fluctuation is the most common. As a rule, extinction can be found to occur in regions otherwise characterized by some degree of fluctuation. Completion seemingly stands by itself, unrelated to fluctuation and extinction. A review of the literature reveals, indeed, that although both the phenomena of extinction and that of completion have been known since World War I their functional relationship has not been considered.

## HISTORICAL REVIEW

The effect of completion was apparently discovered by Poppelreuter<sup>14</sup> and later confirmed in many experiments by Fuchs<sup>8</sup> and by

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24. Halstead's (Function of the Frontal Lobe in Man: The Dynamic Visual Field, Arch. Neurol. & Psychiat. 49:633 [April] 1943) concept of the dynamic field is actually based on a special form of extinction elicited by "double stimulation." He defines as "dynamic field" that portion of the total visual field in which a target is seen peripherally while a form discrimination is being made (simultaneously) in the center of the field.

Goldstein and Gelb.<sup>25</sup> These authors agree on the following facts: Whenever simple figures (solid and outline circles, solid squares) are exposed to hemianoptic subjects in such a way that one half or more of the figure falls into the intact portion and the remainder into the defective portion of the visual field, the figure is seen completely; on the other hand, asymmetric and more complex configurations (letters, drawings) may be recognized by the patient but are never completed. There is unanimity in these observations, but their original interpretation by Poppelreuter has been contested by Fuchs<sup>8</sup> and, again, by Goldstein and Gelb.<sup>25</sup> Poppelreuter<sup>14</sup> himself assumed that the effect of completion was produced by a "totalizing Gestalt conception" (*totalisierende Gestaltauffassung*). But he explained the latter as a psychologic process which provides a simple filling in of missing parts in familiar figures. Thus, he did not consider the possibility of an immediate perceptual process in the visual cortex itself which might account for the actual completion of the image. In a series of experiments, Fuchs<sup>8</sup> was able to show that it is indeed not familiarity with, but the simplicity of, the configuration that is conducive to the completion effect. In this way, he put the effect on a basis similar to that for phenomena observed for the physiologic blindspot<sup>26</sup> and for after-images in subjects with intact visual fields.

After-images have frequently been shown to exhibit such Gestalt effects as "simplification" and "good continuation."<sup>27</sup> But in spite of the theoretic difference between Poppelreuter and the representatives of the Gestalt school, all these authors have stressed that objectively incomplete configurations are just as readily "completed" in defective regions as though they were actually complete. Their observations, therefore, give only incidental evidence for a functional connection between injured and intact areas.<sup>28</sup>

25. Goldstein, K., and Gelb, A.: *Psychologische Analysen hirnpathologischer Fälle auf Grund von Untersuchungen Hirnverletzter*, Leipzig, Johann Ambrosius Barth, 1920.

26. In an old experiment described by Volkmann (1853) and by Wittich (1863) a cross is exposed in such a way that its center falls on the physiologic blindspot.<sup>42</sup> Under such conditions the cross is seen as complete, even though the central portion may actually be omitted from the test figure.

27. Rothschild, N.: *Ueber den Einfluss der Gestalt auf das negative Nachbild ruhender visueller Figuren*, Arch. f. Ophth. **112**:1-28, 1923.

28. In point of fact, in 1 of the cases of Gelb and Goldstein<sup>10</sup> such an interaction was shown between the two halves of a single visual field. On tachistoscopic examination this patient, who was hemiamblyopic, was found to have micropsia in the injured half of his field; objects in the intact half retained their normal size. However, if an object was presented in such a way that portions of it fell to

(Footnote continued on next page)

Such dynamic interaction is more apparent in the phenomenon of extinction (Bender and Furlow<sup>29</sup>), which, in contrast to the completion effect, tends to make the "actual," or "functioning," field of vision much smaller than the fields which would be inferred to exist from perimetric examination alone. The phenomenon was known to Oppenheim,<sup>30</sup> who described it in his textbook of neurology in 1900 and 1923. Head<sup>31</sup> reported it in a case of right hemianopsia. He found that if his patient had both eyes open and "two similar objects were exposed at exactly the same distance from the fixation point, that to the right was frequently not appreciated, although it might be recognized if shown alone."

Poppelreuter<sup>14</sup> attempted to explain the effect as a result of a hemianoptic "weakness of attention." He claimed that an "active direction of attention toward the impaired part of the field" would make simultaneous perception in both half-fields possible. Goldstein, however, has stressed consistently<sup>32</sup> that such an undefined psychologic concept as "attention" cannot be invoked to explain these phenomena. He assumed that they give evidence of a general physiologic principle, which he termed "equalization." This equalization is an expression of the continuous background activity in the central nervous system. It tends to abolish existing excitation processes by raising the local threshold after each process. It thereby insures temporal and spatial segregation of these processes from each other. Over partly impaired cortex this equalization takes place in an irregular fashion; it usually enhances the intact portions and depresses the impaired portions on simultaneous excitation.

More recently, this dynamic interaction between the impaired and the unimpaired part of a field of vision was demonstrated in a patient with a gunshot wound involving the left parieto-occipital lobe.<sup>29</sup> Since then, a considerable number of patients with trauma of the central nervous system have been found to exhibit the phenomenon in the

either side of the dividing line between the halves of the field, the whole object was reduced in size, in proportion to the extent to which the object overlapped into the impaired area.

29. Bender, M. B., and Furlow, L. T.: Phenomenon of Visual Extinction in Homonymous Fields and Psychologic Principles Involved, *Arch. Neurol. & Psychiat.* **53**:29-33 (Jan.) 1945.

30. Oppenheim, H.: *Diseases of the Nervous System*, translated by E. E. Mayer, Philadelphia, J. B. Lippincott & Co., 1900, p. 59; *Lehrbuch der Nervenkrankheiten*, ed. 7, Berlin, S. Karger, 1923, p. 113.

31. Head, H.: *Aphasia and Kindred Disorders of Speech*, London, Cambridge University Press, 1926, vol. 1, p. 439; vol. 2, p. 108.

32. Goldstein, K., in discussion on Bender, M. B., and Furlow, L. T.: Phenomenon of Visual Extinction in Homonymous Fields, *Tr. Am. Neurol. A.* **70**:87-92, 1944; footnote 17.

visual sphere, and frequently for other modalities, especially the cutaneous senses,<sup>33</sup> the nature of the phenomenon depending of course on the site of the lesion. The name "extinction" was given to the clinical phenomenon, in analogy to Dusser de Barenne's<sup>34</sup> physiologic term. Reider<sup>35</sup> recently examined a similar group of patients and called the condition the "suppression" phenomenon.

Although pathologic fluctuation, extinction and completion were thus discovered and rediscovered in a somewhat haphazard manner, it is well to remember that equivalents or analogies for each of these phenomena in the perceptions of normal subjects were already known to experimental psychologists and had been analyzed in systematic laboratory research. Thus, fluctuation in defective fields is actually only a special case of the so-called fluctuation of attention, which the aurist Urbantschitsch<sup>36</sup> discovered as early as 1875 to be a general phenomenon for weak auditory stimuli in every observer. Guilford<sup>37</sup> (1926), in his reevaluation of previous research, described vividly how this problem of fluctuation of attention has been "settled and unsettled at least four times in as many generations of experimental psychology." Explanations in terms of peripheral and of central factors have been proposed. More recently, intermodal aspects of fluctuation in normal persons have come to the fore. By emphasis on the latter, Guilford himself could establish a definite central factor in the causation of these phenomena. But even the more recent experiments of Fry and Robertson<sup>38</sup> left the problem essentially unsettled.

Effects akin to extinction with double stimulation in defective fields have been adduced in theories about the deviations of normal binocular fields of vision from the geometric horopter (the sum of those spatial points whose images at a given ocular position fall onto corresponding retinal points). Thus, the Aubert-Förster phenomenon,<sup>39</sup>

33. Bender, M. B.: Extinction and Precipitation of Cutaneous Sensations, *Arch. Neurol. & Psychiat.* **54**:1-9 (July) 1945.

34. Dusser de Barenne, G., and McCulloch, W. S.: Factors for Facilitation and Extinction in the Central Nervous System, *J. Neurophysiol.* **2**:319-355, 1939.

35. Reider, N.: Phenomena of Sensory Suppression, *Arch. Neurol. & Psychiat.* this issue, p. 583.

36. Urbantschitsch, V.: Ueber eine Eigentümlichkeit der Schallempfindungen geringster Intensität, *Centralbl. f. d. med. Wissensch.* **13**:625-628, 1875.

37. Guilford, F. P.: Fluctuations of Attention with Weak Visual Stimuli, *Am. J. Psychol.* **38**:534-585, 1926.

38. Fry, G. A., and Robertson, V. M.: The Physiological Basis of the Periodic Merging of Area into Background, *Am. J. Psychol.* **47**:644-655, 1935.

39. (a) Aubert, H.: *Physiologie der Netzhaut*, Breslau, E. Morgenstern, 1865, pp. 234-253. (b) Jaensch, E. R.: *Zur Analyse der Gesichtswahrnehmungen*, *Ztschr. f. Psychol. (supp.)* **4**:1-26, 1909. (c) Freeman, E.: *Anomalies of Visual Acuity*

(Footnote continued on next page)

i. e., the shrinking of the normal visual field with increase in perceived distance, has been combined with observations on the intensification of colors in micropsia induced with a plus lens (Koster phenomenon) in Kaila's <sup>39d</sup> hypothesis of a "central inhibition of images" (*Hemmung*). This inhibition is presumed to produce qualitative and quantitative changes in perception as soon as the observer assumes a set for "distance." From a more physiologic point of view, Fry <sup>40</sup> investigated the suppression of a single flash of light immediately followed by a second flash of light projected onto adjacent areas of the retina. Like Piéron,<sup>41</sup> Fry stressed peripheral factors in his attempts to explain these phenomena.

Completion, finally, has received even more attention from the experimental psychologists than has fluctuation or extinction. For in the normal subject the completion effect is represented by the phenomenon of "continuation" and of "closure" of visual configurations, as studied by the Gestalt school. Closure of incomplete Gestalten was found to occur particularly under conditions of rapid tachistoscopic exposure or low illumination, in other words, under conditions approaching the instability of a pathologic visual field.<sup>42</sup>

In the present study, the phenomena of completion and extinction were investigated in detail in a series of patients with damage to the brain and some of the determining factors, particularly the time relationships involved, analyzed. Observations made on after-images and in tachistoscopic and perimetric examinations were compared for each patient. Various supplementary methods as previously listed were applied whenever it seemed indicated. The following questions were considered with regard to the processes in their visual fields:

1. Is extinction an important factor in the visual performance of unselected groups of patients with partial field defects?
2. Do phenomena of "extinction" and "completion" occur with about equal frequency, and, if so, are they likely to be related?
3. Is it thus possible to consider extinction and completion in conjunction with each other and thereby to understand more clearly the dynamics of impaired (and unimpaired) visual fields?
4. In particular, is it feasible to explain thus some of the incongruities in fields obtained with the methods of perimetry, tachistoscropy and after-imagery?

in Relation to Intensity of Illumination, *Am. J. Psychol.* **42**:287-294, 1930. (d)  
Kaila, E.: Eine neue Theorie des Aubert-Försterschen Phänomens, *Ztschr. f. Psychol.* **86**:193-235, 1921.

40. Fry, G. A.: Depression of Activity Aroused by a Flash of Light by Applying a Second Flash Immediately Afterwards to Adjacent Areas of Retina, *Am. J. Physiol.* **108**:701-707, 1934.

41. Piéron, H.: Le processus du métacontraste, *J. de psychol. norm. et path.* **31**:5-24, 1935.

42. Koffka, K.: *Principles of Gestalt Psychology*, New York, Harcourt, Brace and Company, Inc., 1935, p. 145.

## CASE MATERIAL

Three cases from a larger group<sup>43</sup> were selected to illustrate these relationships.

CASE 1.—A 26 year old Marine, was injured in action by shrapnel and a hand grenade. He suffered multiple wounds of the head and body. Aboard a hospital ship, it was noted that he had paralysis of the left arm and leg. There was no aphasia, even though the patient had always been left handed. There was a depressed fracture of the right temporal bone, with a metallic fragment deeply embedded in the brain (fig. 1). His vision was "foggy," and four weeks after the injury a left homonymous hemianopsia was recognized in confrontation tests. When received at the hospital with which we were associated, he still showed a left hemisensory syndrome, and repeated perimetric and tangent screen examinations revealed a macula-splitting left homonymous hemianopsia (fig. 2). At this time, fourteen weeks after the injury, the patient was no longer aware of his field defect, and objects did not appear to be split on fixation, as they had during the first two months following his injury, when he saw only the right half of each object.

*Tests for Completion Phenomenon.*—After-Imagery: The patient was confronted with an American flag, measuring 10 by 18 cm., drawn in complementary colors, and he was asked to focus his gaze on the star in the right lower corner, 30 cm. away from him. He was also instructed to find this star by looking for it from right to left. It was found that during fixation the patient did not perceive anything to the left of his fixation point (fig. 3A). A pencil which was moved back and forth over the flag immediately to the left of the point of fixation was not

43. The present report confines itself to observations on and deductions made from cases of presumably pure "organic" disease. In addition to these cases, our series included several in which perceptual disturbances had been classified by us as hysterical or psychotic. Nevertheless, these were studied by the same methods for comparative purposes. We realize that the distinction between the so-called organic and the nonorganic disturbances is usually arbitrary. But we used the following main criteria in accepting the changes in perception as being directly related to structural defects: (1) presence of a demonstrable lesion in the brain; (2) history of subjective disturbances consequent to the cerebral injury and related to the perceptual changes studied; (3) consistency of the patient's reports during different examinations and under varied conditions; (4) conformity of the subjective and objective changes observed to psychologic, pertinent, well established principles of normal function, as well as to facts already known about pathologic changes in perception following cerebral lesions, and (5) similarity of a patient's special symptoms to those shown by the majority of the patients in the group suspected of having an organic lesion. This consistency among patients was so striking that we could use it as one of the principal criteria. With these standards the differentiation could be made without too much difficulty. However, the perceptual disturbances in the whole series formed a continuum from an "organic" to a "psychogenic" syndrome. For that reason, it is expected that continued controlled experiments on perception in subjects with organic lesions will lead eventually to a fuller understanding of the pathologic processes in patients whose disorders have still to be considered as "merely neurotic."

seen, even though this moving stimulus was applied for the entire thirty second period of focusing. In the after-image, however, the patient saw a considerable portion of the left half of the field, as indicated by the sketch (fig. 3*B*). This increase in the area of visibility represents a type of completion. The extent of "completion" to the left (beyond the fixation point) amounted to from 5 to 9 degrees. The phenomenon was consistent from trial to trial and from day to day.

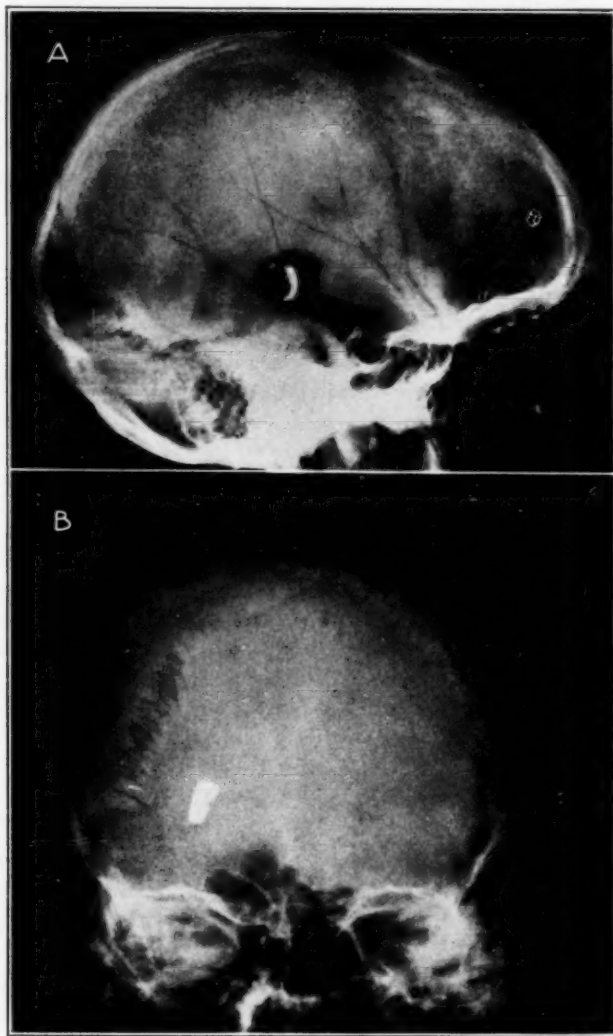


Fig. 1 (case 1).—Roentgenograms of the skull, right lateral (*A*) and antero-posterior (*B*) views. On Aug. 2, 1945 (ten months after the injury) the largest metallic fragment was surgically removed from the lower anterior portion of the thalamus. The state of the fields and the dynamic aspects of the patient's visual organization were unchanged after this operation.

**Tachistoscopic Exposure:** The patient was seated in a totally darkened room, at a distance of 75 cm. from a milk glass screen, 36 by 44 cm. in size. Behind the screen, and shielded from the patient's view, was a tachistoscope. In the center

of the screen was a small black disk, 0.5 cm. in diameter, which served as a point of fixation during the experiments to be described. To insure maintained fixation on this point in the center of the screen, the whole screen was faintly illuminated (0.07 foot candle) from the side opposite the patient.<sup>44</sup> By means of a small cone of light, moving behind the screen, the patient's fields were plotted (as though on a tangent screen), and the existence of the complete homonymous hemianopsia was found to be confirmed under these conditions.

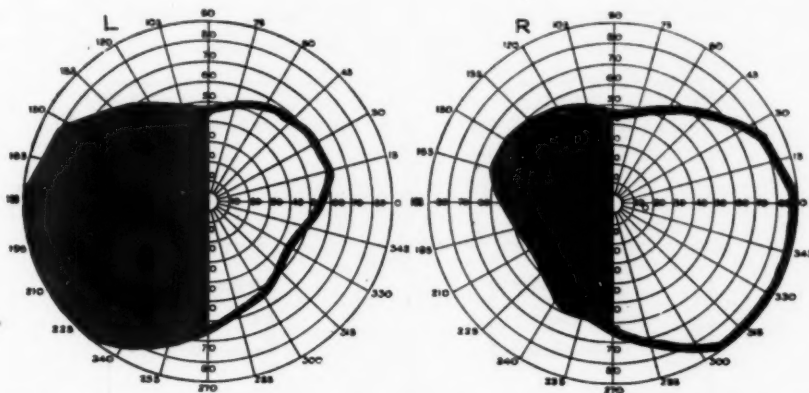


Fig. 2 (case 1).—Left homonymous hemianopsia. The "macula splitting," as well as complete amaurosis in the left half of each field, were constant changes found in all perimetric examinations.

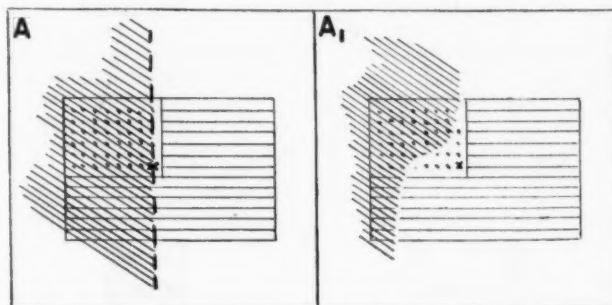


Fig. 3 (case 1).—A, appearance of drawing of the American flag (10 by 18 cm.) during maintained fixation on a star in the right lower corner, indicated by X, 30 cm. from patient's eyes. The shaded area indicates the region of apparent blindness. The macula appeared to be "split." A<sub>1</sub>, appearance of the complementary after-image of the drawing, after a 30 second period of exposure. A considerable portion of the flag to the left of the fixation point had become visible in the negative after-image, representing a form of "completion."

44. This was done in each instance after a period of five minutes of total darkness had been allowed for dark adaptation. The amount of adaptation achieved by the patient prior to entering the examining room was not controlled. For this reason there was no strict uniformity of initial adaptation from test session to test session and from patient to patient, but the differences were probably negligible and became of still less significance during the latter part of each session.

A pattern of four dots, arranged as an oblong (fig. 4 *A*) was projected against the screen (time exposure). The pairs of dots were 14 cm. to the right and to the left of the fixation point, a distance which corresponded under the experimental conditions to an angular distance of about 10 degrees. With continuous exposure, our patient saw only the two dots to the right, that is, in his uninvolved half fields, regardless of whether both eyes, the right eye or the left eye was used.

*Experiment 1:* Tachistoscopic exposure of this pattern of dots (fig. 4 *A*) at all speeds from 1 to 1/150 second did not increase the area seen by the patient. He never reported more than the two dots situated in his right field of vision; the two dots in his left field were not seen under these conditions. A brief negative

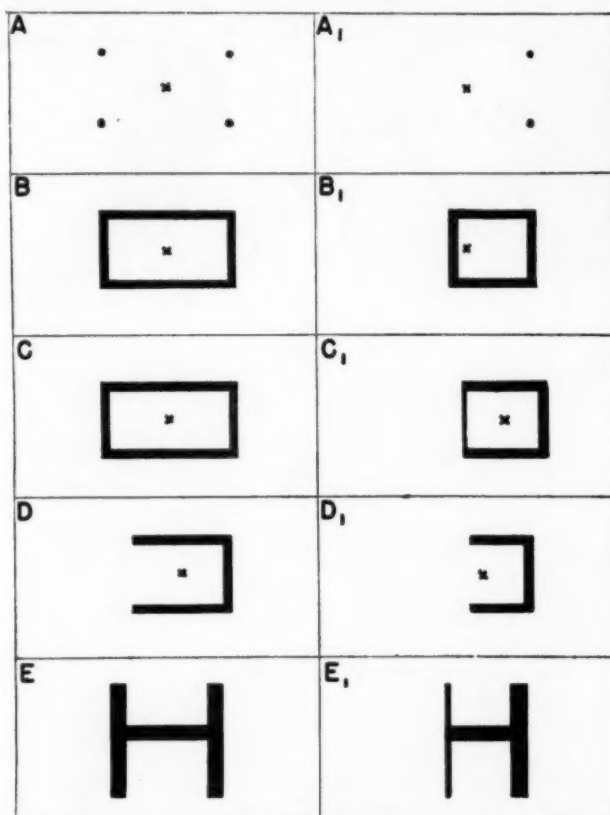


Fig. 4 (case 1).—Test patterns used in investigating completion effects on tachistoscopic exposure. (*A-D*) All presented figures (with the exception of *C*) subtended an angle of 10 degrees to either side of the fixation point (*X*). What the patient saw on rapid exposure (1/150 and 1/100 second) is indicated in the corresponding figures *A<sub>1</sub>-D<sub>1</sub>*.

after-image of the perceived dots was seen with exposures of 1/100 and 1/150 second but not with lower speeds.

*Experiment 2:* An oblong (fig. 4 *B*) with vertical edges, again 14 cm., or 10 degrees, to either side of the fixation point, was substituted for the four dot pattern. At a speed of 1/150 second the patient saw this pattern as a square (fig. 4 *B<sub>1</sub>*). He was definite in stating that it was a complete and undistorted square. Occasionally, however, on repeated testing with speeds of 1/100 to 1/150 second, he

volunteered that the left vertical side of the square appeared thinner than the other three lines (fig. 4C<sub>1</sub>). The same square was seen as incomplete about half the time with speeds below 1/50 second, and it appeared always incomplete with speeds below 1/20 second.

*Experiment 3:* An "incomplete square" (fig. 4D) was substituted for the oblong. The figure opened to the patient's left. When this incomplete square was flashed at a speed of 1/150 second, the patient felt that this was "not as good a square" and asked the experimenter whether it was actually complete. He was not certain whether he saw it as incomplete. On rapid testing with complete and incomplete figures alternating at random, he always said that the two figures were different. He was positive that the presented complete oblong, such as that in figure 4B and C, was a complete square, but he was hesitant in saying what the exposed incomplete square such as that in figure 4D, looked like. He stated characteristically, "I just can't tell because I don't see all of it."

*Experiment 4:* A letter H in heavy black lines, with the verticals again about 10 degrees to either side of the fixation point (fig. 4E), was exposed at a speed of 1/150 second. The patient saw a complete H, but the vertical line to his left appeared thinner than the one to his right (fig. 4E<sub>1</sub>).

In order to maintain proper fixation, various precautions were taken throughout the tachistoscopic tests. Immediately preceding each exposure the patient was instructed to check on his fixation and to report whether he was ready.<sup>45</sup> Furthermore, the exposures of complete and incomplete oblongs were interspersed with exposures of the four dot pattern. The patient always reported only the two dots to his right, regardless of the speed at which they were presented, thus indicating that his fixation did not shift to any great extent.

*Comment.*—According to his visual after-imagery, the patient was not as hemianoptic as was suspected from the perimetric studies. There was a tendency to complete the image. It will be noted that the "completion" of the image never occurred during prolonged fixation, in which movements of the eyes must have repeatedly carried parts of the left half of the flag over the fixation point and into the patient's right, or better, field. Yet, in the after-image the flag appeared with considerable portions added to the left. In other words, the patient's hemianopsia was macula splitting during exposure, but in the after-image the macula seemed to be spared. The phenomenon cannot be explained in terms of the usual behavior of after-images which is demonstrable in normal subjects. There, one finds frequently the characteristic simplification of the configuration which has been

45. In these circumstances, it was frequently noted on replotting the central field that the line of division between the scotomatous area and the area of full vision had shifted to the left by about 5 cm. This shift of the midline by 3 to 4 degrees can be taken as an indication that the patient was now using a pseudo-fovea for fixation, since he felt that he was still maintaining fixation on the disk in the center. It is not impossible that such an unnoticed shift of the patient's eyes to his left might have occurred in some of the test exposures. But the extent of the shift (3 degrees) is not sufficient to explain the patient's sudden ability (under rapid exposure) to see objects at an angular distance of 10 degrees from his original fixation point.

exposed, for instance, rounding of protruding corners, loss of inside detail and occasionally, a "filling in" of gaps in surface or contour.<sup>42</sup> Yet in our case the portion that appeared to be "filled in" in the after-image did not produce a smoothing of contours; on the contrary, it represented a fairly irregular addition, which can be interpreted only in terms of a reduction in the size of the scotoma under conditions of after-imagery.

On tachistoscopic tests this patient undoubtedly showed completion of a continuous figure into the scotomatous area whenever the speed of exposure was sufficiently rapid. The figures were seen as incomplete with lower speeds. Whenever the patient did complete a figure, part of which fell on the scotomatous region of his field, it was not in the sense of a "psychologic filling in" of a missing part (as suggested by Poppelreuter<sup>14</sup>). Completion did not occur when the presented figure was actually incomplete. The latter observation would seem to conflict with those made under similar conditions by the Gestalt school, according to which completion appeared to be a form of "Gestalt closure."

As previously noted, both Poppelreuter<sup>14</sup> and Fuchs<sup>8</sup> found that those parts of the stimulus pattern which fell into amaurotic or amblyopic regions might be omitted without interfering with the completion effect. Fuchs, however, pointed out that this was a matter of degree; the effect was dependent on the proportion between the part of the figure exposed to the intact region of the field and the part exposed to the impaired region. These spatial factors were emphasized by Fuchs, while he gave only scanty attention to the temporal factors which we have stressed in the present study.

However, a Gestalt factor in a slightly different sense, viz., "continuation," must have been operative in producing the completion effect in our patient. If a configuration was discontinuous in all quadrants, completion did not take place.<sup>46</sup>

CASE 2.—A 20 year old seaman first class exhibited visual field defects after he had sustained injuries to the head and face in action in the Pacific. A bullet had entered the cranial cavity through the right posterior parietal region and lodged in the right frontal lobe (fig. 5). When he came under our observation, nine months after the injury, he showed a mild left hemiparesis and a characteristic hemisensory syndrome. Perimetric examination of the visual fields showed a defect in the extreme periphery of the lower left temporal quadrant. On prolonged fixation at a central point, he exhibited continual fluctuation and obscuration in the left half-fields, particularly in the lower left quadrants (fig. 6).

46. Thus, he could see only one half of a dot pattern; i. e., he saw it in keeping with his perimetric field and in contrast to the oblong, which was completed. Additional experiments showed that this effect was due to discontinuity of the pattern and not to the fact that the four dots, in combination, covered less area than the oblong.

*Extinction with Double Stimulation Method.*—However, when this patient's fields were plotted against a dimly illuminated screen (0.07 foot candle), neither the movement of a cone of light 5 cm. in diameter nor the shadow of a hand was perceived by him at any angular distance exceeding 11 degrees from the fixation point, in the lower left quadrant. In other words, the illuminated surface, surrounded by a dark background and extending to either side of the fixation point, was conducive to continual "extinction" in the defective field. This extinction could be shown to occur in this patient on double stimulation in the heteronymous



Fig. 5 (case 2).—Roentgenogram of the skull, right lateral view. The bullet penetrated the right parietal bone and came to rest in the right frontal area. Note the defect and fragments of bone in the parietal region.

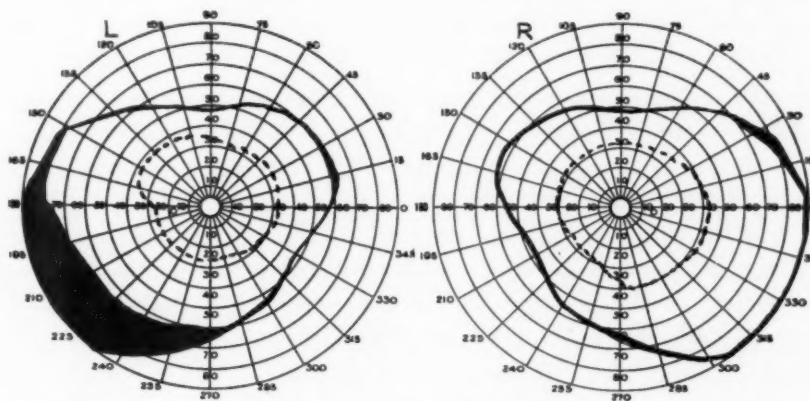


Fig. 6 (case 2).—Perimetric fields obtained under our standard conditions (illumination,  $7\frac{1}{2}$  foot candles; distance, 33 cm.; 1 degree targets) nine months after the head injury. The black areas indicate no perception for motion; the lines of dashes, outline of fields for red. The defect in the extreme periphery of the lower left temporal quadrant suggested an earlier incomplete homonymous hemianopsia. On prolonged fixation, there were rapid and continual fluctuation and obscuration in the temporal half of the left field of vision, particularly in the lower quadrants. On double stimulation to the right and the left of the median plane, everything in the left lower quadrants became extinct at and beyond 11 degrees from the fixation point.

half-fields. He exhibited the same sort of extinction for simultaneous stimulation of the skin receptors on the contralateral side of his body.

However, there was no evidence of spatial disorientation in the affected half-fields, a condition which may have been due to the fact that the density of the "dynamic" scotoma increased steadily toward the periphery and finally merged into the peripheral absolute scotoma. There were, furthermore, no indications of increased ocular unrest, nor was there any awareness of the scotoma.

*After-Imagery.*—The patient's after-images, in contrast to those in our first case, did not illustrate the principle under consideration, since he saw the full image of the original flag during exposure. In the after-image, however, the field defect was represented by a lack of chroma on the left side of the image, an observation which suggests an interference of the opposite half-fields. Thus, he saw the flag exposed in his left field of vision as gray in the after-image. With repeated testing, the after-image assumed a faint color, showing a light blue field and pink stripes.

*Completion Phenomenon on Tachistoscopic Exposure.*—Under the same experimental conditions as those in case 1, the patient was seated in a darkened room 40 cm. from the opaque screen of the tachistoscope, and the field defect was plotted on the screen as it extended toward the periphery in the patient's left lower quadrant, at 8 cm. (11 degrees) from the fixation point. In the area of the scotoma not even movement of a hand was appreciated beyond this angular distance.

The four dot pattern was given with time exposure and then at varying speeds. Only three dots were seen, with the dot in the lower left corner always missing, when the time exposure was greater than 1 second.

The oblong was then exposed at 1/150 second, and appeared as a complete and undistorted figure. This effect was always obtained with 1/150 second's exposure. Conversely, the oblong was always seen as incomplete in the lower left quadrant with a 1 second exposure. In 7 out of 10 exposures it was incomplete with 1/2 second's exposure and in 4 out of 10 exposures, with 1/10 second's exposure; with 1/150 second's exposure it was complete 7 out of 10 times.

*Comment.*—This case suggested that the completion in tachistoscopic exposure was nearly a direct function of the speed of exposure. The higher the speed, the more readily was the configuration completed. Control exposures of presented incomplete figures again showed that normal "closure" of patterns could not be the primary factor. Since the scotoma, in contrast to the conditions in our first case, was only relative in the regions close to the macula, the completion effect appeared more clearly as a function of "suppressed" extinction. That is, higher speeds of exposure made extinction (which is presumed to take time) impossible, while continuous exposure with moderate brightness, or simultaneous stimulations, resulted in extinction in the defective area.

Occasionally, the patient reported negative after-images after a tachistoscopic exposure. The images were too faint and too few to be analyzed. Otherwise we should have tried to determine whether these negative after-images showed the same amount of completion

as the immediately preceding original images or whether they exceeded the latter by being even more "complete." However, the occurrence of after-images as such suggested the hypothesis that completion on tachistoscopic exposure may be merely a result of the appearance of negative after-images. The completion of the latter would be the primary phenomenon, and the patient, while seemingly responding to the original images, would actually be describing the appearance of the after-effect.

After-images are indeed unavoidable during tachistoscopic examinations unless special precautions are taken to prevent their appearance (e. g., very bright after-fields). These after-images, it has been pointed out frequently,<sup>20</sup> may increase the actual time of exposure in an uncontrolled fashion. If they had occurred more often in our second case, even the observed increase in completion with increasing speed of exposure could be interpreted in terms of steady after-image completion. Throughout our series of cases, we noted that very rapid tachistoscopic exposures of configurations with strong contrast tended to produce stronger and more persistent after-images than exposures at low speed.

In subsequent experiments, we therefore instructed our patients always to report whether an after-image (positive or negative) was seen after tachistoscopic exposure. Moreover, bright after-fields were frequently given immediately after tachistoscopic exposure in order to abolish after-images which might have been formed. Our third case illustrates the results with these after-fields and with additional controls, in the conditions of stimulation.

CASE 3.—Our third example was provided by a patient with homonymous scotomas in all four quadrants. Three and a half months before he came under our observation, a 20 year old fireman first class, had been struck by shrapnel in the occiput and sustained a compound fracture of the skull (fig. 7). Both occipital lobes were damaged, and there was complete blindness which lasted ten minutes. For about a week he had slight aphasia and numbness in the tips of the fingers of his right hand. On examination at this hospital, he complained of sensations of "electric shock." This sensation could be elicited on bending his neck. All other sensory disturbances had become minimal.

Examination of the oculomotor system, including vestibular reactions, revealed nothing abnormal except for spontaneous zigzag ocular movements in the horizontal plane during prolonged fixation. These sudden and jerky excursions were fleeting, disappearing after one or two seconds. They were particularly evident during perimetric measurements and other studies of the visual fields.

The remaining outstanding symptoms were in the visual sphere. Here the patient showed a condition almost complementary to that in case 2. On perimetric examination (fig. 8 *A* and *B*) a large absolute scotoma was found extending 25 degrees from the fixation point in the right lower homonymous quadrants. Beyond this area the scotoma extended toward the periphery, but it had much less density. In the latter region the patient showed fluctuation in his ability to see even motion. That is, movement was appreciated in this region but not consistently.

He would suddenly find he could perceive a moving object or a light (in a dark room) in the right lower quadrant of his field of vision, but more frequently he noted that he was totally blind in this area. In other words, the interval of blindness was much longer than the phase of his ability to see in this area of fluctuating function.<sup>47</sup> Whenever he did see in this defective quadrant, he exhibited

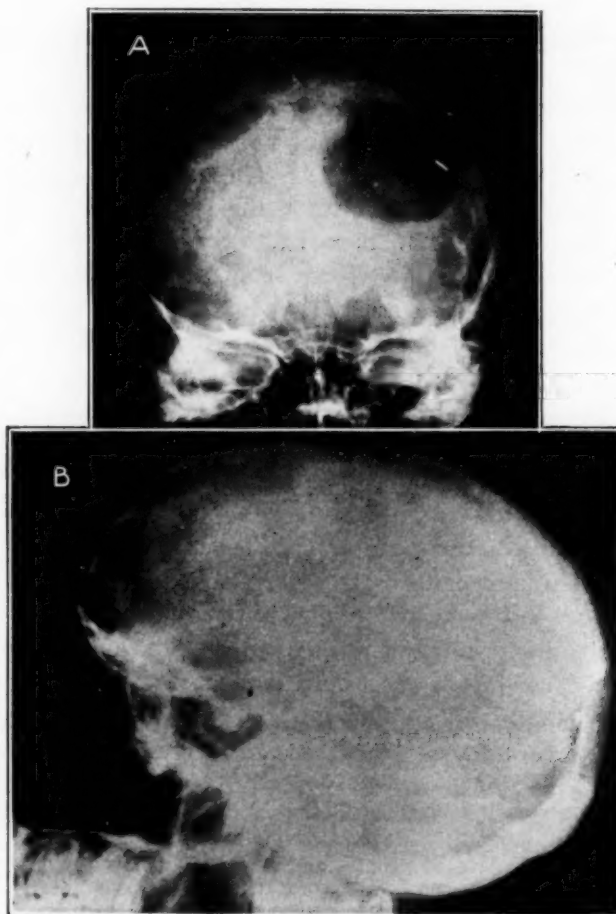


Fig. 7 (case 3).—Roentgenograms of the skull, showing large circular defect in the occiput. Although the bony defect is to the left of the midline, the available evidence indicates damage to both occipital lobes.

a complete spatial disorientation both in the coronal and in the sagittal plane. The disorientation involved localization of points and appreciation of direction of movement.<sup>48</sup>

47. Ordinarily, in an area of fluctuating vision (as originally defined) the phase of ability to see is longer than the interval of disappearance of the image.

48. It may be assumed that both the spatial disorientation and the ocular zigzag movement, previously noted, were dependent on the fact that his scotoma did not extend with equal density all the way into the periphery. The patient in our

*Awareness.*—1. Another feature of the patient's disorganization in perception was awareness of an inequality of his subjective fields of vision. He complained that his right eye was partly covered with a large circular spot of fog. When he tested each eye separately, he said that the left eye was also partly covered with a cloud but that the latter seemed much smaller than the one on the right. Both these subjective obstructions were localized by him to the right lower quadrant. He was able to see these clouds with the eyes open or closed and they were so

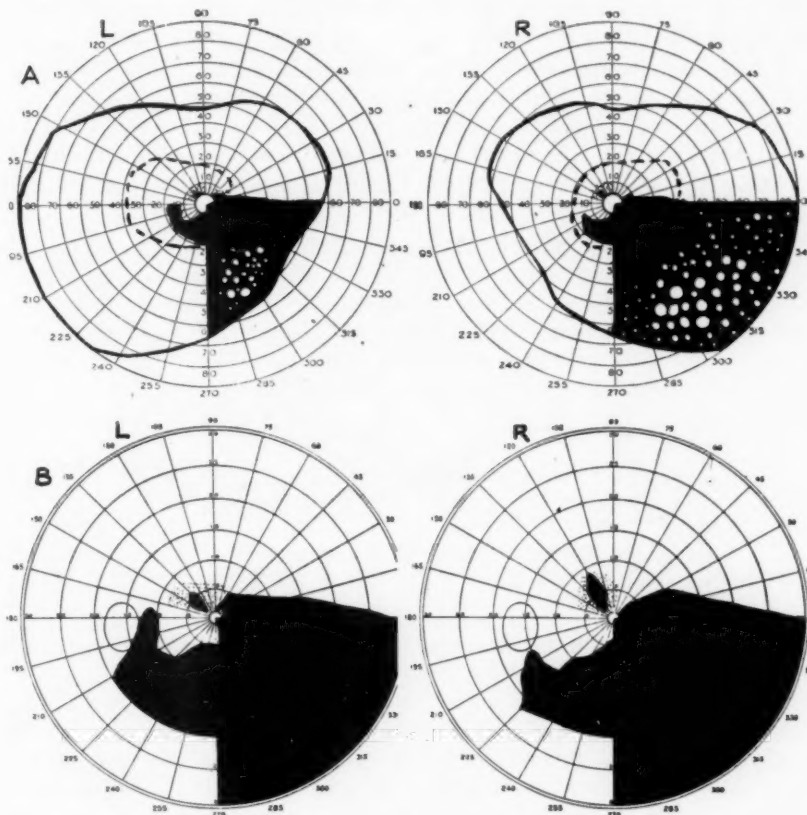


Fig. 8 (case 3).—Visual fields in perimetric (A) and tangent screen (B) examinations, revealing homonymous scotomas in all four quadrants. The solid black indicates zones of amaurosis, and stippling indicates amblyopia. As apparent in the right inferior quadrants, the scotoma is absolute (for 1 degree targets) to 25 degrees from the fixation point. Beyond that, the white stippling indicates an area in which vision was found to fluctuate. At a given point, a perceived image would disappear and reappear at a variable rate; the duration of visibility was much shorter than that of invisibility. In this area, the patient showed spatial disorientation and dysmorphopsia. To a lesser extent he showed such disturbances in the other quadrants.

pronounced that he could easily draw them (fig. 9). When they were compared with the scotoma obtained on the perimeter for the right lower quadrants, the second case in which conditions in the field were reversed, showed no awareness of scotoma, disorientation or apparent increase in spontaneous ocular movement.

clouds seemed to be roughly related to the plotted defect. However, they differed from the perimetric field inasmuch as the subjective scotoma appeared larger to the right eye than it appeared to the left.

2. After numerous examinations over a period of weeks, the patient suddenly became aware of a "new spot of foggiess" in the upper temporal quadrant of the left eye. He was not aware of a similarly situated spot in the right eye unless he tested himself repeatedly. This new spot was apparently determined by the congruent scotomas as recorded in both left upper quadrants. But in spite of the appearance of a "new spot" in the left eye the patient still maintained that the "right eye is worse than the left."

3. As the examinations of his visual performance were continued, he became aware of a third "spot." It was localized in the upper temporal quadrant of the right eye and was described as being yellow, like a small light. This was visible to him with the eyes closed or open, but it was extremely transient. Of all the spots of which he became aware, the one in the right lower quadrant was the most prominent.

*Bisection of Lines.*—With the changes in awareness of his field of vision his ability to bisect lines was altered. Before he became aware of the spot in the left upper quadrant, he usually bisected the line by displacing the estimated center toward the point of fixation. The degree of displacement was the same for both eyes. Afterward, the displacement was in the same direction, but the degree became most pronounced in the temporal half of the left eye.



Fig. 9 (case 3).—Patient's drawing of the scotomas, of which he was constantly aware. Although the plotted scotomas are more or less congruent, the patient felt that his right eye was "worse" than his left, because a large fog seemed to cover it from the right. On testing himself, he found a considerably smaller "fog" in the left eye. In his drawings the patient spontaneously indicated the boundaries of his visual fields by adding the crude outline of an eye.

*Completion on After-Imagery.*—During exposure of the American flag, drawn in complementary colors, at a distance of 30 cm. the patient did not see the whole pattern when tested under any condition provided fixation was maintained at a given point. The portions in the pattern which seemed to him to be missing during prolonged fixation corresponded to the subjective field with its awareness of scotoma.

1. Fixation with Both Eyes: (a) The flag in his entire lower right field was invisible to him. The region of invisibility extended into his visual field "like a bulge" (fig. 10 A).

(b) In the after-image, however, after 60 seconds' exposure, somewhat less was "cut off" from the original image (fig. 10 A<sub>1</sub>).

2. Fixation Only with His Right Eye: (a) During fixation the patient reported that there was an area of obscured vision (to the right of the point of fixation). This area appeared smaller than the one reported on fixation with both eyes (fig. 10 B). In addition to the area of obscured vision to the right, the patient reported an area of complete haziness above and to the left of the fixation point. This represented evidently the insular scotoma in the upper left quadrant (cf. patient's visual fields, figure 8).

(b) In the after-image, the scotoma in the upper nasal quadrant was not manifest. Moreover, the defect in the lower temporal quadrant had become much smaller (fig. 10  $B_1$ ). The completion effect elicited by stimulation of the right eye was evidently more pronounced than that obtained with stimulation of both eyes.

3. (a) *Fixation with His Left Eye:* The defect in the lower right quadrant was at a sharper angle and less extensive than the obscured area noted on fixing with the right eye (cf. patient's attempt to draw his own visual fields, figure 9). The patient again noted an obscure area in the upper left quadrant (fig. 10  $C$ ).

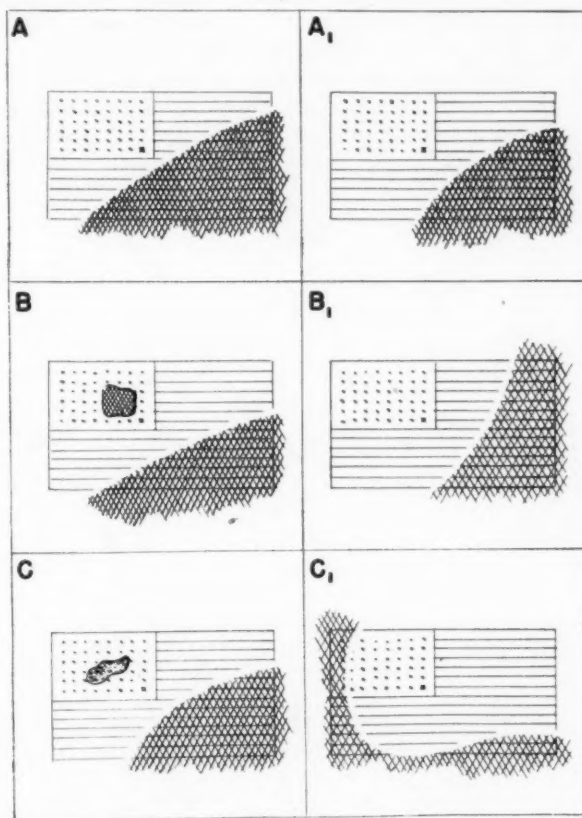


Fig. 10 (case 3).—Patient's visual impressions of the American flag drawn in complementary colors (10 by 18 cm.). In all instances, fixation was maintained on the star in the right lower corner of the field of stars (indicated by an X) 30 cm. away from the eye, under daylight illumination. Shaded areas indicate parts of the flag which were invisible to the patient in the exposed flag ( $A$  to  $C$ ) and in the negative after-images ( $A_1$  to  $C_1$ ).  $A$  indicates his impressions on fixating with both eyes;  $B$ , on fixating with the right eye, and  $C$ , on fixating with the left eye. The corresponding negative after-images illustrate various degrees of completion. The latter was most marked for the left eye. In  $B$  the small shaded area indicates a region which appeared to the patient as a "dark blotch." The small stippled area in  $C$  denotes a region in which the stars "kept running together."

(b) In the after-image from the left eye the completion was most pronounced (fig. 10  $C_1$ ). Only a marginal defect was seen, which surrounded the lower horizontal and the left vertical border of the stimulus pattern, apparently fusing the

two discontinuous areas of invisibility and at the same time displacing them outward.

*Completion on Tachistoscopic Examination.*—Under experimental conditions identical with those in cases 1 and 2, this patient was confronted with three series of tachistoscopic tests:

**TEST SERIES A:** The first consisted of a regular set of slides employed in testing tachistoscopic perception in patients with head trauma. This series included arrays of figures and letters; geometric patterns, line drawings of objects, animals and faces, and, finally, colored slides showing complex scenes. With this material, we did not find a linear, or an approximately linear, relationship between speed of exposure and amount of completion achieved. At very high speeds, 1/75 and 1/100 second, the patient showed poor performance, suggestive of a generally decreased ability for rapid perception and recognition of complex patterns. At very low speeds (1 second) performance was good, probably owing to scanning movements of the eyes, which could frequently be detected by direct

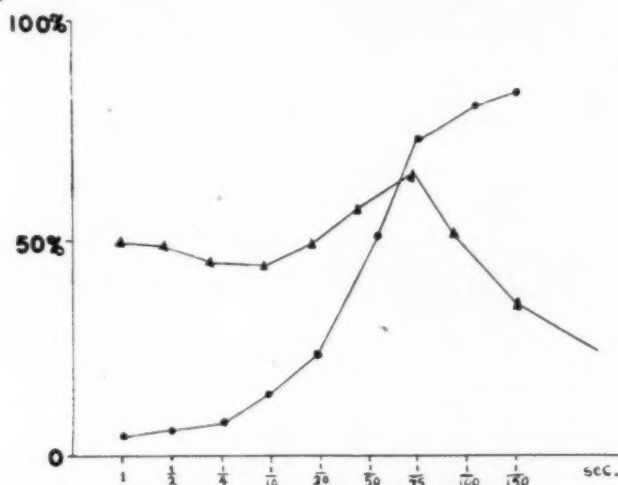


Fig. 11 (case 3).—Graphs showing various degrees of "completion" on tachistoscopic examination. The ordinate indicates estimated degrees of completion in terms of area; the abscissa, time of exposure. Circles represent mean responses for large simple configurations, such as geometric figures; triangles, mean responses for complex linear designs, such as outlines of faces and animals. Note that the simple configurations were seen best with higher speeds. At high speeds, 1/100 second and above, recognition of complex designs became impossible, and outlines were ill defined. At low speeds, 1/10 second and below, performance was good but was associated with scanning movements of the eyes. In the intermediate range performance varied directly with speed of exposure.

observation. In an intermediate range, however, the effect of completion could be seen rather clearly: from 1/10 to 1/50 second's exposure an increase in speed improved performance, and less and less in the patient's right field was missed (fig. 11).

**TEST SERIES B:** When tested with large simple configurations (e.g., a letter H, black on white, covering most of the screen), the completion became a nearly linear function of the speed of exposure (fig. 11). After-images, whenever they occurred, were reported by the patient. The conditions of exposure were varied (bright and dark after-fields, presented at random) in order to minimize the

effect of the after-image on tachistoscopic recognition, and no systematic interdependence between appearance of positive or negative after-images and completion could be found.

**TEST SERIES C:** In order to analyze the factors in completion more closely, special patterns were presented which made it possible to stimulate only one quadrant, or two, or three or all four quadrants, at a single exposure. A schematic summary of the more important results is given in figure 12.<sup>49</sup>

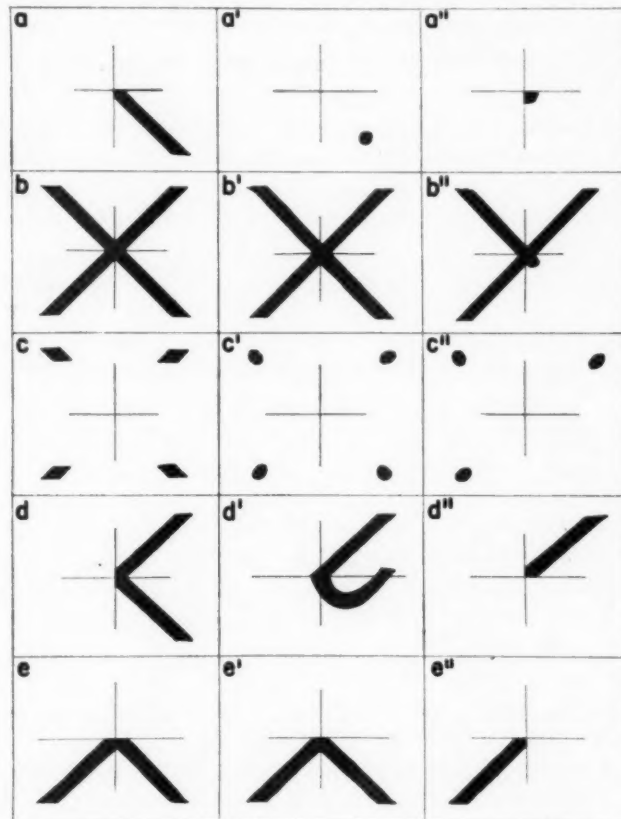


Fig. 12 (case 3).—Various degrees of completion obtained on tachistoscopic examination. Column 1: test patterns exposed. Column 2: patient's own drawings of the pattern (as he saw it at 1/150 second's exposure), demonstrating varying amounts of completion. In the right inferior quadrant shaded areas indicate a "fuzzy" appearance. Note the simultaneous completion and displacement in *d'*. Column 3: patient's indications of same test patterns at specified lower speeds, illustrating failure to "complete." During the test sessions the order of test patterns, as well as the succession of speeds, was at random. The patient was ignorant of the number of actual configurations used.

49. The patterns were produced by a large X cutt into a dark slide so that a bright figure appeared during exposure on a dark ground. With different masks, one, two or three quadrants could be covered. In similar fashion, the central area could be obscured so that only the four extreme tips of the X

(Footnote continued on next page)

1. When single momentary stimulation was given in the most defective quadrant (lower right) only (fig. 12a), the patient saw either nothing or an indistinct flash of light.

2. When repeated stimulation was given under the same conditions (with random exposure of other patterns interspersed), the following results were obtained:

At 1/100 second: A "white square, cut off to the right" (fig. 12a") (no completion)

At 1/150 second: A "white blur in extreme right" (fig. 12a') (no completion; question of displacement)

At 1/50 to 1/20 second: "A rectangle in center cut off to the right" (fig. 12a") (no completion)

3. When the whole pattern was exposed over all four quadrants (fig. 12b) at a speed of 1/150 second, the patient saw it whole, or almost whole, with a small gap in the lower right quadrant (fig. 12b') (definite completion effect). At speeds below 1/20 second the patient saw most of the area in the lower right quadrant as "cut off" (fig. 12b").

4. The original figure was then transformed into a four dot pattern (fig. 12c). At a speed of 1/150 second the patient reported four dots, "one in each corner" (definite completion effect, in spite of discontinuity of pattern). At a speed of 1 second only three dots (and nothing in the lower right quadrant) were reported.

5. When the left half-field was covered and the upper and lower right quadrants were exposed (fig. 12d) (at a speed of 1/20 second and below), the patient saw only an "arrow" slanting through the upper right quadrant (fig. 12d"). At a speed of 1/150 second he saw the same diagonal through the upper right quadrant and another line extending from the center down into the lower right quadrant, then curving back toward the upper right quadrant. This lower line did not appear quite as long as the upper one (fig. 12d') (definite completion, with simultaneous displacement in spite of the high speed of exposure).

6. When both upper quadrants were obscured and the lower right and left quadrants exposed (fig. 12e), the patient failed repeatedly to see anything in the lower right quadrant, even with speeds up to 1/100 second (fig. 12e"). However, at a speed of 1/150 second he saw the diagonal through the lower right quadrant in addition to the one in the lower left quadrant and reported that only "very little" of the lower tip on the right seemed to be "cut off" (fig. 12e').

7. Control exposures with patterns only in one, two or three of the three quadrants exclusive of the lower right showed that the patient was not guessing. Even at speeds as high as 1/150 second he did not fill in by confabulation.

*Comment.*—This patient showed phenomena of fluctuation, extinction and completion. He was also acutely aware of some of his scotomas and attributed them usually to one eye. Under observation this awareness changed. The subjective fields and their subsequent changes seemed to be related to the amount of extinction and completion shown in various visual tests.

were visible. The presentation of the various modifications of the original pattern were made in such an order that the patient remained unaware of the fact that only one slide and one pattern were being used.

Extinction appeared to be most pronounced on double stimulation and on prolonged exposure. Thus, on maintained fixation on a point in the flag used for producing after-images, various areas of the test pattern were invisible. These areas were different in extent in the binocular field and in the monocular fields for each eye, respectively. This was contrary to the vision one would expect from the patient's perimetric fields, where the areas of scotoma were nearly congruent. The differences in binocular and in monocular fields as obtained on prolonged exposure were more in keeping with the patient's subjective fields, or with his awareness of scotoma. Binocularly, the scotoma in the upper left quadrant (of which the patient was still unaware at the time of these experiments) did not appear on prolonged fixation. It did appear on prolonged fixation with the right or with the left eye. The massive scotoma in the right lower quadrants appeared largest on binocular fixation, somewhat smaller on fixation with the right eye and smallest on fixation with the left eye. It is suggested that these differences in visual fields as elicited on prolonged exposure are functions of different degrees of extinction. Subjectively, the patient always felt that vision in his left eye was better, or "less obscured," than vision in his right eye. Our assumption of unequal degrees of extinction might put the patient's impression on an objective basis.<sup>50</sup>

Completion appeared in the patient's after-imagery and on tachistoscopic examination. In the after-images the differences between the fields were not only maintained but proportionately increased; the smallest completion effect was noted after binocular stimulation. After monocular stimulation of the right eye a somewhat larger amount was "completed," and after fixation with the left eye the completion effects were most pronounced. The completion effects, as demonstrated by after-imagery, were thus much more in keeping with the patient's subjective fields of vision than were his perimetric fields.

In weighing this evidence an obvious objection should be considered: Since the patient had considerable difficulty in maintaining fixation, one might suspect that the completion phenomena in his after-imagery were due simply to involuntary ocular movements which carried the

50. The patient's insistence that his left eye was better (in spite of the congruence of scotomas as plotted for the left and the right eye) was probably related to the superiority of the nasal half of each retina over the corresponding temporal half. According to Koellner's hypothesis,<sup>10</sup> there is never perfect retinal correspondence. The crossed fibers in man dominate over the uncrossed fibers. Thus, the left half of any binocular field is predominantly determined by the impressions supplied through the left eye. This accords well with the observation that patients whose lesion is restricted to one occipital lobe (or is more severe in one occipital lobe) complain of impaired vision in the eye contralateral to the lesion.

image periodically into better parts of his field. The increase in the area of the after-image would then appear as a summation of various composite views gained through some kind of scanning activity. However, a number of facts speak against this explanation.

1. Wide variations in time of exposure did not increase or decrease the completion effect.

2. Observations on after-imagery in normal subjects and in subjects with nystagmus show that ocular movements during exposure lead to suppression rather than to enhancement of after-images.<sup>50a</sup>

3. Completion of after-images following tachistoscopic exposure could be shown in this patient to be most marked with high speeds of exposure (1/100, 1/150 second), situations into which ocular movements could not possibly have entered.

Results of the various tachistoscopic examinations show the completion effect most clearly as a fairly linear function of speed of exposure whenever simple continuous patterns were being used (test series B). In contrast to observations in cases 1 and 2, and to the results in the majority of earlier cases reported in the literature,<sup>51</sup> the patient in this case showed completion even for discontinuous dot patterns. However, these patterns were regular symmetric configurations and in some ways were equivalent to continuous Gestalten (e.g., the four dot pattern arranged as an oblong, oriented symmetrically to the median plane).

Even with complex, meaningful stimulus patterns (arrays of letters, line drawings) some completion could be obtained, again in contrast to the results in earlier reports.<sup>52</sup> But the distribution of results from test series A suggests that the patient's over-all performance with this material could not possibly give a simple indication of the amount of completion that could be achieved. Rather, it represented a test of recognition. With high speeds of exposure the patient's general "slowing" of recognition produced a considerable number of failures. At low speeds the scanning movements previously mentioned disrupted the attempted control of experimental conditions. In spite of this, completion appeared as a function of speed of exposure over an intermediate range of speeds.

Of the results from test series C, finally, the following points should be emphasized:

- (a). The completion effect is not obtained with any speed of exposure when only the defective quadrant itself is stimulated.

50a. Bender, M. B., and Teuber, H. L.: Nystagmoid Movements and Visual Perception, *Arch. Neurol. & Psychiat.* **55**:511 (May) 1946.

51. Fuchs.<sup>8</sup> Poppelreuter.<sup>14</sup>

52. Fuchs.<sup>8</sup> Poppelreuter.<sup>14</sup> Goldstein.<sup>17</sup>

(b) Completion with high speeds appears greatest on simultaneous stimulation of the most defective quadrant and of the relatively normal quadrant, such as that in the opposite half of the field.

(c). The spatial disorientation found in the patient's lower right quadrant under ordinary conditions can be shown to occur even on tachistoscopic stimulation with speeds as high as 1/150 second. If the upper and lower right quadrants are stimulated simultaneously in this situation, completion and displacement can occur at the same time.<sup>53</sup>

#### SUMMARY AND CONCLUSIONS

In 3 illustrative cases of disturbances of visual fields with scotomas of varying extent and density, phenomena of fluctuation, extinction and completion were observed. The three phenomena appeared to be related to each other. Fluctuation was characteristic of all cases, particularly on prolonged exposure. Extinction seemed to represent a more extreme form of fluctuation, since it occurred readily in areas which were otherwise characterized by fluctuation. In these areas extinction could be demonstrated frequently on double simultaneous stimulation. With rapid tachistoscopic exposure of patterns, the defects in the visual fields seemed to be reduced in their extent in all 3 cases. This fact suggested that these field defects (though produced by circumscribed lesions) were a result of processes of extinction rather than signs of a permanent loss in function. For that reason, rapid tachistoscopic exposure would prevent extinction and produce the appearance of completion. Completion could thus be understood as a simple absence of "extinction."

If such dynamic processes as fluctuation, extinction and completion determine the actual (functioning) visual fields, it is unjustified to think in terms of a point for point correspondence between function and substrate. The visual projection area seems to operate in an integral fashion. Even circumscribed lesions do not necessarily produce functional loss of an all or none character.

Widely different visual fields can be plotted for one and the same case by using different methods of field taking. Even the patient's

53. Throughout the tachistoscopic examinations, only slight, if any, differences in the amount of completion were found for the binocular, the right and left fields, respectively. A tendency for the left eye to obtain more completion than the right was apparent, but it was so small as to be insignificant. For this reason, results for each eye and for binocular exposure were pooled in the accounts which went before. When retested after he had become aware of the scotoma in the left upper quadrant (for his left eye), the patient showed definitely less completion (in the left visual field and in the binocular fields) than before. Similar concomitant changes in the extent of the subjective field and the amount of completion have been reported by Fuchs.<sup>8</sup>

subjective fields (his awareness of scotoma) may be indicative of physiologic principles which are operative in the impaired substrate.

It is assumed that in such impaired tissues there is a marked lability of threshold.<sup>17</sup> In his discussion on Bender and Furlow's paper on Extinction,<sup>32</sup> Goldstein summarized his own theories by relating lability of threshold and extinction in the impaired portion of the nerve substrate to an increase in energy needed by the damaged portion of the cortex. The resultant gradient in excitability is a dynamic affair, just as normal dominance might be. That is, it is not a stable condition but a process which has to occur after each stimulation and which takes a certain time to come into play over the total cortical field in which the perceptual processes are taking place.

These spatial and temporal aspects of increased dominance would explain why extinction does not take place instantaneously on stimulation in involved and uninvolved fields. The increased fluctuation and obscuration in amblyopic regions could likewise be interpreted as an indication of a periodic recovery in the substrate's ability to function at lower thresholds.

Fluctuation, extinction and completion appear as general principles of function rather than as pathologic variations. They are brought to a focus only by the pathologic conditions. Fluctuation can be found in every normal visual field in the extreme periphery. With near threshold intensity of stimulation, it can be demonstrated also for the foveal region. Extinction and completion likewise are assumed to be processes in normal perception. Completion appears in the phenomena of Gestalt closure and "good continuation." Extinction, in particular, has usually been considered as a rare disturbance of perception in cases of injury to the brain. Our observations suggest, on the contrary, that extinction may play its role in many different field defects and that it might indeed be a feature in normal perception. It is suggested that extinction may be operative in certain phenomena of the normal visual space, such as the Aubert-Förster phenomenon. Conditions as different as the absolute hemianopsia (case 1) and the quadrant amblyopia with spatial disorientation (case 3) show similar features in respect to extinction and completion. For, under special conditions, particularly with high speed tachistoscopic exposure, images appear definitely more complete than those perceived with long exposure under conditions in which extinction would have time to take place.

Our completion effects were so striking with speeds of 1/100 to 1/150 second that (besides adducing the negative factor of absence of extinction) we are tempted to infer a positive aspect of the same central process—namely, precipitation. For at these high speeds the effect was more marked with simultaneous stimulation of the

unimpaired parts of the field than with stimulation of the involved area alone. Dusser de Barenne and McCulloch<sup>54</sup> have shown that facilitation can be an early phase of extinction in a cortical focus and that both seem to depend on continual background activity. These phenomena probably play a major role in normal reciprocal innervation.

- In pathologic states precipitation as well as extinction can be demonstrated for cutaneous sensibilities.<sup>54</sup> Our observations make it likely that both precipitation and extinction take place even between areas of a single visual field, in analogy to the concomitance of binocular interference and binocular enhancement.

In 2 out of 3 cases, completion effects were also obtained for the patient's negative after-images, which formed after a period of prolonged fixation. Observations in our series of cases are in progress which may answer the question whether "completion" in tachistoscopic exposure and in after-imagery are usually found to occur together in the same patient or whether they are readily dissociated. Until more definite data are at hand regarding the incidence of completion effects under different conditions, it will be difficult to decide whether the completion effects in tachistoscopic exposure and in after-imagery have the same or different causation.

The fact that after-imagery produced phenomena similar to tachistoscopic perception in our cases is difficult to explain. One might assume that central components of after-images are formed suddenly after a process of gradual summation and, while being formed, show the phenomena of irradiation into partly destroyed cortical tissues.<sup>55</sup> But very little is known about the central components in after-imagery. The complex nature of our stimulus pattern makes it unlikely that completion in the after-image was due in our cases to a simple Gestalt effect ("continuation" or "closure").

Another explanation may be considered. The completed after-image is due to the very first phase of the visual stimulus. It has been pointed out that the patients can see more of an object with short (1/100 second) than with long (1/10 second or more) exposures. It would seem possible, therefore, that the pattern which is present in the first 1/100 second of a long exposure acts as a stimulus in the formation of an after-image. Hence, despite the fact that the patient sees only the smaller pattern during prolonged fixation, the removal of

54. Bender.<sup>33</sup> Reider.<sup>35</sup>

55. "Irradiation" was originally hypothetically assumed (Plateau, cited by Duke-Elder, W. S.: Textbook of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 1, p. 80) in order to explain simultaneous contrast. Plateau thought in terms of spread of excitation over adjacent parts of the retina. His ideas were generally abandoned (for the peripheral level) until Piéron formulated his own theory of *métacontraste*.<sup>41</sup>

the visual stimulus results in a negative after-image of the initial, larger or more complete design.

A phenomenon which may be related to the completion of visual after-images is the after-sensation experienced on removal of a stimulus when cutaneous sensory adaptation takes place. Thus, when the skin becomes adapted to a continuous pressure stimulus, and after a certain interval (adaptation time) this stimulus becomes imperceptible, the removal of the stimulus even many seconds later will evoke an after-sensation, which reestablishes the original pressure percept. In certain pathologic cases we found that such after-sensations exceeded the original sensation in intensity and articulateness.

It should, finally, be considered that completion, and other phenomena described in this communication, are not confined to visual and cutaneous perception. Taken in a wider sense, they can be found to pervade the so-called higher functions, such as processes of memory and thought.<sup>42</sup> Studies in reminiscence are a case in point. The principles of function which are signalized in the phenomena of fluctuation, extinction and completion may thus have general application.

1192 Park Avenue, New York.

## News and Comment

### OPPORTUNITY FOR TRAINING IN THE VETERANS ADMINISTRATION

The opportunities today for training in psychiatry and its practice present a situation unique in medicine. Not only has the public become increasingly aware of the possibilities and limitations of psychiatry, but the medical profession as a whole realizes the nature of the intimate relations of its practice to psychiatry. This obviously would mean an increasing load of patients in any circumstances; in addition, there is now the great number of veterans needing care. This number is expected to increase.

The Veterans Administration offers an opportunity to men of pioneer spirit, eager to practice their specialty in favorable circumstances. Teachers are needed in the hospitals and in medical schools, seasoned men who enjoy teaching and who are interested in research and the study of methods of communicating clinical wisdom to the less experienced. The patients are there. The medical schools are using members of their staffs for teaching, supervision and case consultation. Full time teachers are being placed in some hospitals.

The administration also needs men of all types of experience who can benefit from training on the job. It needs those who can organize and administer hospitals and clinics, as well as treat patients. It needs residents who may have little or no formal training in psychiatry but who intend to complete their training for Board certification and to stay in neuropsychiatry.

It has been attempted to make salaries throughout the neuropsychiatric service in keeping with the dignity of the medical profession. Salaries range from \$3,300 for the resident who is a veteran to \$9,800, with 25 per cent additional compensation for those who have Board certifications.

Every effort is being made to organize the work so that a minimum of time will be spent on administrative duties and paper work and the maximum with the patient. This will take time to accomplish, but we are committed to this policy.

The resident program is outlined as follows:

1. Appointment is approved by the Deans' Committee. Approval is forwarded by the Deans' Committee to the manager. The manager makes the appointment. The resident is placed on the payroll at the manager's office.
2. Fifty per cent of the time of the resident is spent with Veterans Administration facilities.
3. Veterans Administration physicians are to share in training without loss of grade when time and staff capacity permit.
4. Medical schools or other sponsors of trainees are to receive appropriate tuition per resident on a yearly basis.
5. Teachers are to be recompensed in the following manner:
  - (a) Consultants (men of professorial or associate or assistant professorial grade) are to receive \$50 per visit.
  - (b) Attending physicians (men with specialty Board certification and on the teaching staffs or institutions) are to receive up to \$25 a visit.

Specific details on the entire neuropsychiatric program can be obtained by writing to the Veterans Administration Neuropsychiatric Service, Washington 25, D. C. A list of medical schools now receiving applications for resident training follows.

Medical School	Veterans Administration Institution	Applications Received by
University of California Medical School Stanford University School of Medicine	Palo Alto, Calif.	*Dr. Karl Bowman, University of California Medical School, San Francisco
University of Southern California School of Medicine College of Medical Evangelists	Sawtelle, Calif.	*Dr. Samuel Ingham, 727 West Seventh Street, Los Angeles
University of Louisville School of Medicine	Nichols General Hospital	*Dr. S. Spafford Ackerly, University of Louisville School of Medicine, Louisville, Ky.
University of Michigan Medical School	Fort Custer, Mich.	Dr. Raymond Waggoner, University of Michigan Medical School, Ann Arbor, Mich.
University of Minnesota Medical School	St. Cloud, Minn.	Dr. Donald Hastings, University of Minnesota Medical School, Minneapolis
Cornell University Medical College	Bronx, N. Y.	Dr. Oscar Diethelm, New York Hospital, New York
Long Island College of Medicine	Northport, N. Y.	Dr. Howard Potter, Long Island College of Medicine, Brooklyn
New York University College of Medicine	Mental Hygiene Clinic	Dr. Samuel Wortis, Bellevue Hospital, New York 16
Duke University School of Medicine	Mental Hygiene Clinic	*Dr. Maurice Greenhill, Duke University School of Medicine, Durham, N. C.
University of Oregon Medical School	American Lake	Dr. Henry Dixon, University of Oregon Medical School, Portland, Ore.
University of Pennsylvania School of Medicine Temple University School of Medicine Jefferson Medical College of Philadelphia	Coatesville, Pa. Lyons, N. J.	*Dr. Edward Strecker, University of Pennsylvania School of Medicine, Philadelphia
Boston University School of Medicine Tufts College Medical School Harvard Medical School	Mental Hygiene Clinic, West Roxbury, Mass.	*Dr. Harry C. Solomon, Harvard Medical School, Boston
University of Wisconsin Medical School	Mendota, Wis.	*Dr. W. F. Lorenz, University of Wisconsin Medical School, Madison, Wis.
University of Colorado School of Medicine	Mental Hygiene Clinic	Dr. Franklin Ebaugh, University of Colorado School of Medicine, Denver
Western Reserve University School of Medicine	Critchfield General Hospital Winter General Hospital, Topeka, Kan.	Dr. Douglas Bond, Western Reserve University School of Medicine, Cleveland Dr. Karl Menninger, Winter General Hospital, Topeka, Kan.

\* Chairman of Neuropsychiatric Sub-Committee of Deans' Committee.

#### AMERICAN BOARD OF NEUROLOGICAL SURGERY

During the war, in order to cooperate with the surgeons general of the Army and Navy in the classification of specialists, the American Board of Neurological Surgery permitted applicants whose training was satisfactory to take their examination before complying with the requirement of two years' independent practice of neurologic surgery. In no instance, however, was the Board's certificate issued until all requirements had been fulfilled. At its last meeting in Nashville, Tenn., on April 7, 1946, the Board voted to return to its prewar practice, and in the future no candidate will be examined until he has complied with all requirements of the Board as to both training and practice. However, the Board invites prospective candidates to submit their qualifications to the Board when their period of training is completed and before they have begun their period of practice.

## Abstracts from Current Literature

EDITED BY DR. BERNARD J. ALPERS

### Physiology and Biochemistry

THE OXYGEN CONTENT OF CEREBRAL BLOOD IN PATIENTS WITH ACUTE SYMPTOMATIC PSYCHOSES AND ACUTE DESTRUCTIVE BRAIN LESIONS. HAROLD E. HIMWICH and JOSEPH F. FAZEKAS, *Am. J. Psychiat.* **100**:648 (March) 1944.

Himwich and Fazekas studied the difference in oxygen content of arterial and of internal jugular venous blood in a case of each of the following disorders: pernicious anemia with mental symptoms, cardiac decompensation with psychosis and psychosis associated with acute syphilitic encephalitis. In cases of the first two the venous oxygen levels were subnormal, indicating an inadequate cerebral oxygen supply, due in the case of pernicious anemia to decreased oxygen-carrying capacity of the blood and in the case of cardiac decompensation to slow cerebral blood flow. In the case of acute syphilitic encephalitis the venous oxygen level was above normal and the difference in oxygen content of venous and of arterial blood was less than normal. This was interpreted as due to a decrease in removal of oxygen from the blood as a result of the decrease in viable brain tissue.

Himwich and Fazekas state that determination of the oxygen content of the cerebral venous blood may serve to indicate that mental symptoms are produced by inadequate oxygen supply or that they result from changes within the brain. It is necessary to rule out alterations in the rate of cerebral blood flow.

FORSTER, Philadelphia.

CARBONIC ANHYDRASE IN MAMMALIAN TISSUE. W. ASHBY, *J. Biol. Chem.* **151**:521, 1943.

The purpose of this investigation is primarily to study the distribution of carbonic anhydrase in the central nervous system, the results of which will be given in subsequent papers. The present paper deals with an exploration of the possibilities of the technic previously described by use of tissues, some of which, like those of the central nervous system, do not have specific excretory or secretory functions with respect to carbon dioxide, the hydrogen ion or the  $\text{CO}_3$  anion. The aim has been to establish an orientation toward the function of the carbonic anhydrase found in the central nervous system. The carbonic anhydrase content of the following tissues has been studied with the technic previously described, by which the carbonic anhydrase activity of the tissues can be distinguished from that of the contained blood: kidney, divided into medulla and cortex; liver; human striated muscle; adrenal gland; rat embryo, and brain. In the human kidney, the enzyme content of the cortex was higher than that of the medulla. The medulla contained variable amounts of the enzyme. In this series of human muscle, low activity was associated with malignant growths, tuberculosis and extreme old age, and activity was greater after a comparatively rapid death. Variations in results both between species and between individuals were also noted in other tissues. In contrast to the results for the aforementioned tissues, no activity was found in the adrenal gland or in the rat embryo, while an activity approaching 10 per cent of that of the blood was found as a maximum in the central nervous system of 8 species of animals studied. The possible significance of carbonic anhydrase in the brain is discussed.

PAGE, Cleveland.

THE PATTERN OF DISTRIBUTION OF CARBONIC ANHYDRASE IN THE CEREBRUM OF MAN COMPARED WITH THAT OF CERTAIN OF THE LOWER ANIMALS. W. ASHBY, *J. Biol. Chem.* **156**:323, 1944.

In the hog, the dog and the cat a greater amount of carbonic anhydrase has been found in the cortex than in the white matter immediately below it. An average ratio of 34.9:22.5 was found in 20 series tested. In the human brain, as a rule, more carbonic anhydrase was found in the white matter immediately below the cortex than in the cortex. This was the relationship in 81 series from 18 brains. Exception to this excess was found in the motor area of the human brain, where the relationship was that found in the animal brains.

PAGE, Cleveland.

ON THE DISTRIBUTION OF CARBONIC ANHYDRASE IN THE CEREBRUM. W. ASHBY, *J. Biol. Chem.* **156**:331, 1944.

In previous papers data were presented indicating that carbonic anhydrase tends to have a pattern of quantitative distribution in the central nervous system somewhat peculiar to the species studied but, in general, shows an increase rostrally. In the dog, the cat and the hog a steep gradient of increase was found from the brain stem to the pallium. In man this was apparently not the case, the average content of the pallium being equal to or less than that for the rostral end of the pons. Man also differed from the aforementioned animals in that, except in the motor area, the maximum carbonic anhydrase content of the pallium was found immediately below the cortex, while in the animals studied it was found within the cerebral cortex. It was postulated that the carbonic anhydrase in the tissues of the central nervous system might play a part in determining the speed with which energy was made available for conduction of nerve impulses and might therefore determine dominance of an area and the degrees of radiation of an impulse. Further data are added on the amount of carbonic anhydrase in the human pallium. They support the belief of Ashby that there is a parallelism between mental function and carbonic anhydrase content. The pattern of intensity of activity seen in the electroencephalogram shows a good correlation with the patterns found for carbonic anhydrase.

PAGE, Cleveland.

STUDIES ON CHOLINE ACETYLASE: I. EFFECT OF AMINO ACIDS ON THE DIALYZED ENZYME; INHIBITION BY  $\alpha$ -KETO ACIDS. D. NACHMANSOHN and H. M. JOHN, *J. Biol. Chem.* **158**:157, 1945.

Recent investigations have provided evidence that the release and removal of acetylcholine is an intracellular process connected with the nerve action potential. According to a new concept, the active ester depolarizes the neuronal membrane by rendering it permeable to all ions. In a resting condition the membrane is selectively permeable to potassium. Flow of current is thus generated (action potential), which stimulates the adjacent region. There the process is repeated and the impulse in this way propagated along the axon. The properties of the enzyme choline acetylase, which forms acetylcholine under strict anaerobic conditions in the presence of adenosine triphosphate, have been further investigated. In extracts obtained from rat or guinea pig brain, 100 to 150 micrograms of acetylcholine may be formed per gram per hour. The optimal rate decreases rapidly after fifteen minutes of incubation. Adenosine triphosphate is split, in spite of the presence of fluoride, at a rather high rate. An initial concentration of  $3 \times 10^{-8}$  molar is optimal. At this concentration the nucleotide is not the limiting factor of the reaction. The enzyme requires potassium ions. The optimal concentration has been found to be near 0.08 molar, which is approximately that found in mammalian brain. On dialysis the enzyme becomes inactive. In two hours it has lost 80 to 85 per cent of its original activity. Addition of potassium reactivates it only partially. Further, reactivation may be obtained with glutamic acid. Only the natural *l* (+) form is effective. The *d* (—) form has practically no effect.

Cysteine is still more effective than glutamic acid and may reactivate the enzyme almost completely. When combined with cyanide, glutamic acid has an effect almost as strong as cysteine. Of all other amino acids tested, only *l* (+)-alanine enhances the activity of the dialyzed enzyme to a notable degree, but not so much as glutamic acid. The other amino acids have either a weak effect or none. Dicarboxylic acids have no effect on the dialyzed enzyme. Citric acid reactivates it almost as strongly as does glutamic acid;  $\alpha$ -keto acids inhibit the enzymes in  $10^{-3}$  to  $10^{-4}$  molar concentrations. Pyruvic, phenylpyruvic, hydroxyphenylpyruvic and  $\alpha$ -ketoglutaric acids were tested. No inhibition was found with acetoacetic acid. In extracts prepared from powder of acetone-dried brains, choline acetylase has lost only a small fraction of its original activity. Cholinesterase may be almost completely inactivated by treatment with acetone. In this way the two enzymes may be separated.

PAGE, Cleveland.

THE EFFECT OF OXYGEN TENSION ON THE METABOLISM OF CEREBRAL CORTEX, MEDULLA AND SPINAL CORD. FRANCIS N. CRAIG and HENRY K. BEECHER, *J. Neurophysiol.* **6**:135 (March) 1943.

Craig and Beecher studied the rates of oxygen uptake and anaerobic lactic acid production of slices of cortex, medulla and spinal cord. The oxygen uptake in all three tissues was found to be sensitive to oxygen tension. The shape of the oxygen uptake-oxygen tension curve was essentially the same for all three tissues. Anaerobic lactic acid production was twice as great in the cortex as in the medulla and was sensitive to oxygen tension in the cortex and medulla but not in the cord. In the cortex, lactic acid production and oxygen uptake varied inversely when the oxygen tension was altered. In the medulla lactic acid production was maximal at 2 to 3 volumes per cent of oxygen.

FORSTER, Philadelphia.

PROPAGATION OF EPILEPTIFORM IMPULSES IN THE BRAIN: IV. ROLE OF SUBCORTICAL STRUCTURES. S. OBRADOR ALCALDE, *Bol. d. lab. de estud. med. y biol.* **1**:145 (Aug.) 1942.

Obrador Alcalde observed convulsive movements and tonic contractions on stimulating the white substance in cats after extirpating the motor area. The responses to electrical stimulation of the subcortical white substance were different in character from the reaction to electrical stimulation of the cortex, and higher voltages were necessary to elicit reactions.

In some cases of stimulation of the basal ganglia after extirpation of the cerebral hemisphere the only responses were autonomic. In other cases stimulation of the basal ganglia caused tonic contractions with flexion and extension of the extremities, especially those contralateral to the side stimulated; stronger stimulation caused superimposed clonic contractions, and on a few occasions a complete epileptic attack, similar to that seen with intense cortical stimulation, was elicited. The more intense stimuli probably diffused into neighboring, and even distant, structures. It is difficult to evaluate these experiments because they were done soon after cerebral extirpation, and not enough time had elapsed for degeneration of the pyramidal tracts. It was noted at times that the convulsive movements disappeared immediately after stimulation was stopped. This indicated probable stimulation of projection system fibers, since gray cortical matter has more capacity for automatic activity and after-discharge.

Electrical stimulation of subthalamic and hypothalamic regions in some cases caused typical autonomic responses, such as pupillary dilatation, contraction of the nictitating membranes and evacuation of the bladder. In animals under light anesthesia, stimulation of these regions caused excitement, aggressive behavior, mewing, and the like. At times stimulation of these regions caused progression movements of the extremities; violent convulsions were noted with more intense stimulation. The author observed the typical tegmental response of Graham

Brown on stimulating the surface of the brain stem of decerebrate animals. This pattern appeared even when the pyramidal tracts in the bulb were sectioned. In addition to this classic response, the author noted generalized tonic responses in the limbs. He concludes that the generalized convulsion represents the result of physiologic interrelationships at various levels of the neuraxis.

SAVITSKY, New York.

### Neuropathology

PRIMARY SARCOMATOUS MENINGIOMA (PRIMARY SARCOMA OF THE BRAIN). JOSEPH H. GLOBUS, SIDNEY LEVIN and JACK G. SHEPS, *J. Neuropath. & Exper. Neurol.* **3**:311 (Oct.) 1944.

Globus, Levin and Sheps surveyed 150 cases of meningioma, histopathologic study revealing a sarcomatous change in 16 (9.3 per cent). Eight of these cases are included in the present study.

Primary sarcomatous meningiomas usually occur in the first two decades of life. Both sexes are equally represented, and the disease usually runs a clinical course of about six months. Headache was present in all but 1 case and papilledema in 4 of the 8 cases. Primary atrophy of the optic nerve was present in 2 cases, and the disks were normal in 2 cases. Generalized convulsions occurred in 2 cases, and stiff neck and the Kernig sign were present in 4 of the 8 cases. Root pain was present in 4 of the 8 cases; in 2 it was an initial symptom. Surgical intervention afforded only temporary improvement in 5 of 8 cases. Roentgen irradiation also brought only transient relief in 4 cases. In 2 cases there was clinical evidence of multiple lesions, and tumor cells were recognized in the cerebrospinal fluid.

The authors identified 7 of the 8 tumors specifically as sarcomatous pial meningiomas and 1 as a sarcomatous leptomeningioma. The right cerebral hemisphere was the site of the tumor in 3 cases, and the cerebellum, with or without dissemination, in 2 cases; in the same number diffuse and primary involvement of the meninges had occurred. The meninges were partly involved in all the other 6 cases. The choroid plexus was the seat of sarcomatous formation in 1 case. Multiple tumors in all the cranial fossae were found in 1 case, with the largest mass in the parietal lobe. In 1 instance metastasis of the primary pial sarcoma into the regional lymph nodes was definitely ascertained. The cells of this tumor are usually undifferentiated, small, oval cell aggregates along a blood vessel. Giant cells are frequent among the cellular elements but are not essential for diagnostic purposes. Connective tissue is present in all the tumors. The cellular constituents are commonly traceable to derivatives of the pial component of the leptomeninges. Sarcomatous meningioma may give rise to visceral metastasis.

GUTTMAN, Philadelphia.

HERPETIC MENINGO-ENCEPHALITIS. GEORGE B. HASSIN and I. A. RABENS, *J. Neuropath. & Exper. Neurol.* **3**:355 (Oct.) 1944.

Hassin and Rabens report the case of a 48 year old white man who had a cluster of vesicles "characteristic of herpes zoster" over the left frontal region. About sixteen days after the onset of his illness he became increasingly dazed and apathetic, and singultus developed and persisted. The temperature became elevated, and urinary retention ensued. His condition worsened; he became irrational, lapsed into coma and died about twenty-two days after the onset of his illness. The clinical diagnosis was herpetic encephalitis.

Neuropathologic study revealed vascular and widespread degenerative changes (degenerative nonvascular softening) in the subcortex and especially in the pons, medulla and cornu ammonis. There was associated meningitis of both the vertex and the base of the brain, including some of the cranial nerves. Changes in the nerve cells were generally mild, but the nucleoli exhibited tinctorial changes and

occasionally appeared vacuolated. The absence of all inclusions does not speak against the herpetic nature of encephalitis.

The abnormalities differ from those seen with encephalitis lethargica of the von Economo type, trypanosomiasis, the cerebral forms of poliomyelitis and typhus, but resembled the St. Louis type of epidemic encephalitis, equine encephalomyelitis and Borna disease of horses.

A diagnosis of the specific form of encephalitis cannot be made from neuropathologic study without a knowledge of the history or/and additional laboratory tests, such as animal inoculations and immunologic observations.

GUTTMAN, Philadelphia.

### Psychiatry and Psychopathology

THE ROLE OF THE PREMORBID PERSONALITY IN ARTERIOSCLEROTIC PSYCHOSES.  
DAVID ROTHSCHILD, *Am. J. Psychiat.* **100**:501 (Jan.) 1944.

In studying the clinical and anatomic relationships in patients with arteriosclerotic psychosis, Rothschild found many inconsistencies, indicating that different persons vary greatly in their ability to withstand cerebral damage. In only a minority of the patients was the damage of such degree that the quantitative factor could be considered all important. Rothschild found that persons who are in any way handicapped psychologically are highly vulnerable to the development of arteriosclerotic psychoses. Many of his patients displayed inadequate personalities, and less frequently situational stress was noted. He concludes that, while organic cerebral damage can produce a psychosis in any one, the anatomic factor is all important in only a minority of cases and that in the majority of arteriosclerotic psychoses responsibility is shared by personality factors.

FORSTER, Philadelphia.

AGE AND ELECTROENCEPHALOGRAPHIC ABNORMALITY IN NEUROPSYCHIATRIC PATIENTS. MILTON GREENBLATT, MARIE M. HEALEY and GERTRUDE A. JONES, *Am. J. Psychiat.* **101**:82 (July) 1944.

Greenblatt studied the electroencephalograms of 1,593 neuropsychiatric patients and 240 control subjects. Ten per cent of the control group had abnormal records. Rhythms of 8 to 12 per second were considered normal, and abnormal rhythms were divided into slow, fast and mixed slow and fast. Pronounced alterations during hyperventilation were also considered abnormal. The percentages of abnormalities associated with various neuropsychiatric disorders were as follows: alcoholic psychosis, 22 per cent; schizophrenia, 23 per cent; psychopathic personality and behavior disorders, 31 per cent; manic-depressive psychosis, depressed type, 31 per cent; psychoneurosis, 34 per cent; manic-depressive psychosis, manic type, 42 per cent; psychosis with mental deficiency, 50 per cent; involutional psychosis, 51 per cent, and senile and arteriosclerotic psychoses, 54 per cent. With involutional psychosis and manic-depressive psychosis, depressed type, there was a large amount of fast activity, while with senile and arteriosclerotic psychoses, psychosis with mental deficiency, psychopathic personality and behavior disorders there were large amounts of slow activity. Greenblatt found the incidence of abnormalities correlated with the age of the patient, the highest incidence occurring in youth and old age and the lowest between 25 and 45 years of age. The incidence of slow activity decreased between the ages of 15 and 45 to 55 and rose again, while the incidence of fast activity increased within the same range and then declined. Greenblatt concludes that the changes in the electroencephalogram associated with the aforementioned neuropsychiatric conditions are largely explained by variations in age.

FORSTER, Philadelphia.

WAR NEUROSIS IN THE ARMY AND IN CIVILIAN LIFE. TIKHON I. YUDIN, Am.  
Rev. Soviet Med. 1:544 (Aug.) 1944.

Yudin discusses observations on various forms of barotraumatic illness, emotional shock and hysterical reactions, all of which followed bombings and presented a variety of problems of evacuation and therapy.

In the barotraumatic conditions the stunning of consciousness is in the nature of Bleuler's "graduated weakening of consciousness," in that a certain insignificant part of the perceptions is retained and there are a few bridges connecting the patient with reality. After severe contusion or destruction of brain substance the very continuity of consciousness is broken. A subject suffering from barotrauma may be comatose, but muscular tone is preserved. After cerebral contusion the body is flaccid, and soon the patient begins to moan from pain; his face betrays suffering; excitement and twitching are not rare. In emotional shock or hysteria the patient rarely falls to the ground. The pupils are dilated; if there is an initial stuporous state, it disappears rapidly. Questioning elicits a detailed description of the experience during the bombardment.

Yudin distinguishes three forms of barotraumatic reactions. All three forms require complete rest at the beginning of the illness, but each calls for a different therapeutic approach. Cerebrospinal hypertension requires punctures and ultra-short wave therapy. The author recommends iodine iontophoresis for the vascular type. The persistent defects in the hypertensive patients usually bore the character of prolonged apathy, while the vasopathic patients displayed mild euphoria. When "hysterical fixations," such as deaf-mutism appear, ether narcosis and psychotherapy are employed. At first almost all the patients show deaf-mutism, with easy fatigability of sight and altered perception of pain. Depending on the initial trauma, this state persists for one to three weeks and is followed by asthenia without irritability and with subsequent recovery. With the more severe trauma this course takes from two to three months.

The patients are evacuated quickly to special hospitals and are not retained in general hospitals. Immediate therapy resulted in a recovery rate of 93 per cent of the deaf-mute patients in the author's series. The remaining 7 per cent had, for the most part, organic changes in the auditory apparatus. When symptoms of hysteria persist despite treatment, the patient is sent to work under civilian conditions.

The incidence of neuroses, and even psychoses, diminished among the civilian population during the war. Data indicate that the number of neuroses increased only among women in the climacteric period and among males suffering from arteriosclerosis. However, the incidence of the neuroses was reduced as far as possible through care of the families of the front line fighters, the widespread distribution of care in dispensaries and relief of women over 50 from the need to work.

GUTTMAN, Philadelphia.

RORSCHACH METHOD AND PSYCHOSOMATIC DIAGNOSIS: PERSONALITY TRAITS  
OF PATIENTS WITH RHEUMATIC DISEASE, HYPERTENSIVE CARDIOVASCULAR  
DISEASE, CORONARY OCCLUSION, AND FRACTURE. C. KEMPLE, Psychosom.  
Med. 7:85 (March) 1945.

Kemple made Rorschach studies of patients between the ages of 15 and 50 years who had been admitted to the hospital with rheumatic disease, hypertensive cardiovascular disease, coronary occlusion or fracture. The studies showed that there were certain characteristic personality trends associated with each of the illnesses, and the results were in agreement with those of previous research studies using other clinical methods.

The Rorschach tests showed that patients with rheumatic disease are characteristically passive, masochistic, instinctively weak and infantile, with an underlying hysteria. Patients with hypertensive disease are more ambitious for power and have more conscious hostility, and their aggressions and their more dominant passive, dependence needs are more constantly in acute conflict. Obsessive-com-

pulsive defenses are conspicuous and the patients are more introversive. Patients with coronary occlusion are more aggressive and more striving for power and prestige. They are more dependent on external achievement for satisfaction and security and express a great deal of emotion outwardly. Patients with fracture fall into three groups: introversive, constricted and extratensive. In all the groups there is an effort to compromise between passivity and aggression, with a marked emphasis on self determination, independence and day to day pleasure.

These studies indicate that the patient whose personality resembles that associated with a given illness is more likely to have organic damage the more he diverges from psychologically healthy norms and the more he manifests a lack of protective defense mechanisms.

WERMUTH, Philadelphia.

AN EXPERIMENTAL STUDY OF THE FUNCTIONS OF THE FRONTAL LOBES IN MAN.  
G. K. YACORZYNSKI and LOYAL DAVIS, *Psychosom. Med.* 7:97 (March) 1945.

Yacorzynski and Davis tested 5 patients who had undergone unilateral frontal lobectomy (1 patient with a lesion of the left lobe and 4 patients with lesions of the right lobe) by experimental procedures and compared results with those for 8 normal controls. A number of differences were found between the two groups: 1. The patients with lesions of the frontal lobe required a longer time and more illumination to perceive geographic figures and words than did the controls. 2. They did not perceive as many meaningful objects in ambiguous figures. 3. The illusory effect of the Müller-Lyer Illusion, measured quantitatively, was exaggerated, and the illusory effects of many other visual illusions were not perceived. 4. They were not able to recall as many objects exposed visually. 5. They did not perceive reversals on many of the figures with reversible perspectives. On the basis of these results, the authors postulate that after unilateral frontal lobectomy (1) a longer time is required to perceive a stimulus, (2) the number of situations which are perceived in a stimulus field is decreased, (3) there is inability to shift readily from one stimulus to another and (4) there is a distortion of normal perceptions.

Other forms of atypical behavior in these patients were noted: Euphoria was present in 2 of the subjects, and the patient with the lesion of the left frontal lobe showed unmistakable symptoms of aphasia. Immediate memory was apparently not affected.

WERMUTH, Philadelphia.

ACUTE NICOTINIC ACID DEFICIENCY (ANIACINOSIS). B. GOTTLIEB, *Brit. M. J.* 1:392 (March 18) 1944.

Gottlieb believes that the lives of many middle-aged and elderly persons exhibiting mental confusion of undetermined cause could be saved by the prompt administration of nicotinic acid. The condition, probably nicotinic acid deficiency, may be manifested by mental confusion, delusions, hallucinations, stupor, manic excitement and confabulations. In most cases no other evidence of vitamin deficiency except pellagra, thiamine deficiency, ophthalmoplegia or scurvy is found. Of diagnostic importance are the dietetic history, a history of chronic alcoholism and response to treatment with nicotinic acid. Treatment consists of the administration of 100 mg. of nicotinic acid or 30 mg. of nicotinamide hourly for ten doses in the first two days by mouth or stomach tube, followed by administration of 500 mg. of nicotinic acid daily for a few more days in five doses and then a residual dose of 25 mg. three times a day. In addition, Marmite (extract of yeast containing the vitamin B complex),  $\frac{1}{2}$  ounce (15 Gm.), or Bemax (preparation of the seed germ of certain cereals containing vitamin A, thiamine, riboflavin and vitamin E), 1 to 2 ounces (31 to 62 Gm.), daily, and thiamine hydrochloride, 25 mg. a day, are given. The patient should be placed on a good mixed diet as soon as possible.

ECHOLS, New Orleans.

REHABILITATION OF THE NEUROTIC. LOUIS MINSKI, J. Ment. Sc. **89**:390 (July-Oct.) 1943.

Minski points out that, in his opinion, it is easier to rehabilitate a patient who has suffered from an acute or a recurrent psychosis than it is to rehabilitate the neurotic patient. The illness of the psychotic patient runs a well defined course, but the neurotic patient may have long-drawn-out symptoms, perhaps exaggerated when he returns to work.

The greater number of patients admitted as neurotic to a military emergency hospital were those who should never have been allowed in military life, men who were sick before enlistment or almost so.

But many neurotic persons in the service are merely miscast in their particular job and can be rehabilitated by replacement in a more congenial position. This is also true of men for whom strenuous duties are too much but who can fill in at less arduous tasks.

The author describes the procedure in an annex of 200 beds attached to the hospital. Neurotic patients whom it was decided to return eventually to the service were admitted there in uniform, without the somewhat demoralizing influence of wearing "hospital blues." They were given occupations of the heavier types and vigorous physical training. They greatly appreciated the change in dress, i.e., from "blues" to uniform.

Rehabilitation of the neurotic patient involves not only hospital care, with psychotherapy and occupational therapy and discharge, but resettlement in civilian life. It is the body of chronic neurotic patients who are of the most concern here, for, although most of them may have civilian jobs during the war, in peacetime they will not survive competition with healthier brethren. It is for these that the author suggests the establishment of colonies of neurotic patients where the members live and work with their families on an almost self-supporting basis, plus, perhaps, a government subsidy. No disadvantage would be suffered by having so many neurotic persons together, because, in the author's opinion, the neuroses are dependent more on environment than on heredity and the former would be adjusted to the best interests of all. Although the plan would be more expensive at first, in the long run it ought to be cheaper, since it should help to eliminate neurosis, especially when combined with voluntary sterilization if the disease has a hereditary factor.

McCARTER, Boston.

### Diseases of the Brain

FREQUENCY OF CONVULSIVE DISORDERS IN FEEBLEMINDED. R. W. WAGGONER and J. G. SHEPS, Am. J. Psychiat. **100**:497 (Jan.) 1944.

Waggoner and Sheps maintain that the close relation of convulsive disorders to feeble-mindedness is largely due to the presence of many mentally deficient patients in institutions for epileptic patients. The authors therefore studied the incidence of convulsive states in mentally deficient persons. They collected 254 persons with mental deficiency of all types except that associated with congenital syphilis who had lived at least one year and who presented gross or microscopic cerebral lesions. Of this series of 254 patients 105, or 41.34 per cent, had convulsive attacks. Of patients with the exogenous, or acquired, type of mental deficiency 51 per cent had convulsive disorders, whereas of patients with the endogenous type 39 per cent were thus afflicted. The authors found no difference in the incidence of convulsive disorders in the various clinical subdivisions of the endogenous type. They stress the infrequency with which convulsions are associated with mongolism. Investigation revealed an incidence of epilepsy in 3.7 per cent of the parents of patients with convulsive disorders and no epilepsy in the parents of those without seizures.

FORSTER, Philadelphia.

INTRACRANIAL DURAL CYST. WEBB HAYMAKER and MILES E. FOSTER JR., J. Neurosurg. **1**:211 (May) 1944.

Although cysts spatially related to the dura mater have been occasionally reported, only one cyst located solely within the dura has been described; and all the cysts were in the spinal canal. Some of the epidural cysts seemed to be dural diverticula, while others appeared to be herniations of arachnoid through congenital dural defects.

Haymaker and Foster report a case of excruciating headache and blurred vision associated with a large defect in the occipital bone. Craniectomy revealed an intradural cyst of the posterior fossa, containing 100 cc. of fluid. The patient died of complicating meningitis. Autopsy demonstrated that both walls of the cyst were composed of dura. The authors suggest that congenital failure of fusion was responsible for formation of the cyst.

WHITELEY, Philadelphia.

A CASE OF CONGENITAL ATRESIA OF THE FORAMINA OF LUSCHKA AND MAGENDIE: SURGICAL CURE. A. EARL WALKER, J. Neuropath. & Exper. Neurol. **3**:368 (Oct.) 1944.

Walker reports the case of a 20 year old woman who had always had a large head, weakness of the right extremities and unsteady gait. There was a five year history of headaches and fainting spells, usually at the time of the headaches, and in one of these attacks the patient is said to have had clonic movements of the extremities. There were no other abnormal physical or neurologic signs. The correct diagnosis was made clinically on the basis of the roentgenograms of the skull, which revealed that the lateral sinus was conspicuously elevated and the posterior fossa was, accordingly, enormously enlarged. A suboccipital craniectomy was performed and an opening made in the fourth ventricle. Surgical removal of the membrane from the posterior margins of the rhomboid fossa relieved all symptoms, and the patient returned to work. This is the third case to be reported in which the patient survived operation.

GUTTMAN, Philadelphia.

PROLONGED DISTURBANCES OF CONSCIOUSNESS FOLLOWING HEAD INJURY. BURNES E. MOORE and JURGEN RUESCH, New England J. Med. **230**:445 (April 13) 1944.

Moore and Ruesch report studies on 39 patients with prolonged disturbances of consciousness, such as coma, semicoma, confusion, delirium, stupor, drowsiness and dysphasia, which persisted seventy-two hours or more after a head injury. This group of patients represents 8 per cent of all persons with head injuries admitted to the Boston City Hospital during a six month period. The authors analyzed the histories and the frequency and duration of abnormal medical, neurologic and psychiatric symptoms and signs and made an evaluation of various pertinent laboratory studies.

All the patients were examined within two hours after the accident. The duration of hospitalization ranged from four to sixty-two days, with an average of twenty-nine days. After discharge the patients were kept under observation, whenever possible, at home or in the institutions to which they had been transferred. There were 31 males and 8 females. Their ages ranged from 6 to 72 years, with an average of 39 years. Twenty patients (51 per cent) were within the fourth and fifth decades of life. Twenty-three patients (60 per cent) were addicted to alcohol. From the psychiatric viewpoint, 21 patients (54 per cent) were classified as psychopathic personalities. Eighteen patients (46 per cent) acquired their head trauma from a fall, while traffic accidents were responsible for the next largest group, of 14 patients (36 per cent). A variety of incidents accounted for the trauma of the remaining 7 patients (18 per cent).

On the basis of the high incidence of such observations as alteration in the electroencephalographic pattern, fracture of the skull, blood in the spinal fluid with

increased pressure and a Babinski sign, the authors concluded that the prolonged mental confusion is associated with severe damage to the brain. The vital signs were significantly altered in about one-half the cases and appeared to be independent of the presence and duration of confusion. During the period of hospitalization immediately following injury, intellectual disturbances outnumbered other mental abnormalities. Emotional disorders tended to appear later than the cognitive dysfunctions and persisted longer; they were frequent even in cases of short confusion.

Ability to speak returned on an average within the first day. The first response to psychologic tests appeared during the second week, before correct orientation for place, situation and time, which returned in that order. Drowsiness and restlessness held no fixed place in the order of recovery, and appeared to be independent of the course of recovery of intellectual function.

Gross intellectual defect persisted for six months in 31 per cent of the patients, and in each patient it was preceded by a period of confusion lasting longer than nineteen days.

The duration of disorientation proved to be one of the most reliable and easily obtainable criteria of the seriousness of mental disability. The total duration of post-traumatic amnesia is directly related to the period of disorientation and thus has equal value but is obtainable only later, and is then a purely subjective quantity.

GUTTMAN, Philadelphia.

A FORM OF PRESENILE DEMENTIA WITH SPASTIC PARALYSIS. C. WORSTER-DROUGHT, J. G. GREENFIELD and W. H. McMENEMEY, *Brain* 67:38, 1944.

Worster-Drought, Greenfield and McMenemey report the observations at autopsy in an additional member of their previously described family, which was characterized by the occurrence of presenile dementia with spastic paralysis. The patient was a woman aged 51 who had defective memory, impaired intelligence, disorientation, apathy and difficulty in attention, together with spasticity of all four extremities and some incoordination. The illness was of nine years' duration, during which time both the mental changes and the paralysis increased.

On gross examination, the brain and the spinal cord seemed normal. Section of the cerebral hemispheres revealed a diffuse grayish degeneration of the centrum semiovale. Histologic examination of the central nervous system revealed changes similar to those previously described by the authors in another member of the same family. These changes consisted of (1) extreme hyaline thickening of the media of the small arteries of the meninges and of the parenchyma, both of the brain and of the spinal cord, and (2) the presence of peculiar plaquelike structures, often around small blood vessels and most abundant in the cornu ammonis and the cerebellar cortex. Many of the vessels showing the degeneration of the media were surrounded by a narrow zone of rarefaction, and a few had a narrow zone of lymphocytes. Both blood pigment and hemorrhage occurred about some of the degenerated vessels. The arteriolar changes were unlike those seen in hyperpiesis. Wedge-shaped scars and areas of neuronal change in the cortex were ascribed to the vascular changes. The plaquelike structures were well demonstrated by Mallory's phosphotungstic acid hematoxylin stain and consisted of a central, irregular granular body surrounded by a slight condensation of neuroglial fibers passing into the plaque. Most of the plaques contained a few neuroglial fibers running radially through their outer part. The plaques were most numerous in the cornu ammonis, the cerebellum and the inferior olive. Many of the pyramidal neurons of the cornu ammonis had undergone Alzheimer's neurofibrillar change.

The authors conclude that the vascular changes were not due to hyperpiesis and that the plaques were not the result of arteriolar degeneration but, rather, represented a metabolic dyscrasia of the central nervous system.

FORSTER, Philadelphia.

THE NEUROLOGICAL COMPLICATIONS OF DISSECTING AORTIC ANEURYSM. AVERY D. WEISMAN and RAYMOND D. ADAMS, *Brain* **67**:69, 1944.

Weisman and Adams reviewed 38 cases of dissecting aortic aneurysm and found in 11 instances neurologic signs bearing a definite relation to the observations at autopsy. In these 11 cases the duration of illness lasted from six hours to nine days. The cases were divisible into three groups on the basis of the pathologic process: (a) ischemic neuropathy, 9 cases; (b) encephalopathy, 1 case, and (c) myelopathy, 1 case. The neurologic complications were produced by interference with the blood supply of the peripheral or the central nervous system. Clinically, in the cases of ischemic necrosis of the peripheral nerves the patients had pulseless, cold extremities, with weakness, anesthesia and areflexia. In cases of ischemic necrosis of the spinal cord there appeared flaccid paralysis, urinary retention and a sensory level. In a case of ischemic necrosis of the brain confusion, stupor or coma, with flaccid hemiplegia, hemianesthesia and aphasia prevailed. In this case the aneurysm had occluded the left common carotid artery. Dissecting aneurysm may occlude branches of the aorta in three ways: (a) by extension of the dissection into the branch; (b) by thrombosis resulting from narrowing the lumen by dissecting aneurysm, or (c) by shearing of the small branches from the main trunk.

FORSTER, Philadelphia.

EXPERIMENTAL EDEMA OF THE BRAIN: V. VASCULAR PERMEABILITY. S. OBRADOR ALCALDE and J. PI-SUÑER, *Bol. Lab. de estud. med. y biol.* **1**:123 (July) 1942.

Edema of the brain was again produced by lesions in the medulla in the region of the fourth ventricle. Phenolsulfonphthalein was injected in large doses intravenously into animals. Twenty to thirty minutes after injection the brain was removed and studied macroscopically. In addition, emulsions of cerebral tissue were made, to which was added a 5 per cent solution of sodium bicarbonate; the emulsions were studied colorimetrically. None of the coloring matter passed from the capillaries into the swollen cerebral tissue. The dye did not pass into the cerebral substance even in those animals in which elimination of the dye into the urine was prevented. In spite of this absence of experimental evidence in favor of an increase in vascular permeability in experimental edema of the brain, the authors showed in previous experiments that there is an increase in water content of the brain in these animals. This fact would indicate the presence of some degree of capillary permeability. The authors suggest that such permeability may be more readily demonstrable when the edema is of relatively longer duration. It is also pointed out that histologic studies of these animals demonstrated as an almost constant finding the dilatation of perivascular spaces, indicating the probable existence of some degree of permeability.

SAVITSKY, New York.

### Diseases of the Spinal Cord

TUMORS IN THE SPINAL CANAL IN CHILDHOOD: II. ANALYSIS OF THE LITERATURE OF A SUBSEQUENT DECADE (1933-1943); REPORT OF A CASE OF MENINGITIS DUE TO AN INTRAMEDULLARY EPIDERMOID COMMUNICATION WITH A DERMAL SINUS. WALLACE B. HAMBY, *J. Neuropath. & Exper. Neurol.* **3**:397 (Oct.) 1944.

Hamby states that in a survey of the literature in 1933 reports of 100 cases of intraspinal tumors in children of 15 years or younger were found. In the subsequent decade (1933-1942, inclusive) 114 such cases were reported. The distribution of neoplasms in the combined series was as follows: gliomas, 20.6 per cent; sarcomas, 19.6 per cent; dermoids, 17.3 per cent; neurinomas, 10.7 per cent; lipomas, 4.7 per cent; meningiomas, 4.7 per cent; chloromas, 4.2 per cent; tumors

of blood vessels, 3.3 per cent; tumors of the sympathetic nervous system, 2.8 per cent, and miscellaneous tumors, 12.1 per cent. In all, there were 21 "hourglass tumors," a percentage of 9.8. Seven cases of spinal epidural cysts are described in the literature of the last decade.

Hamby reports the case of a 3½ year old boy who recovered from influenzal meningitis and a subsequent attack of meningitis. Several surgical procedures were performed. At first a sacral dermal mass was incised and drained. Finally, an infected epidermoid cyst, extending from a sacral dermal sinus into the congenitally elongated spinal cord, was evacuated but could not be completely freed from the surrounding neural tissue.

GUTTMAN, Philadelphia.

THE CLINICAL SIGNIFICANCE OF BACTERIURIA IN PATIENTS WITH SPINAL-CORD INJURIES. DANIEL BADAL, DONALD MUNRO and MARION E. LAMB, New England J. Med. **230**:688 (June 8) 1944.

Using the technic employed in the neurosurgical service of the Boston City Hospital, Badal, Munro and Lamb report their observations on cultures of urine of 53 of 169 patients with lesions at various levels of the spinal cord and cauda equina. A total of 578 cultures were examined during the course of the study. *Proteus vulgaris*, *Escherichia coli*, the alpha hemolytic streptococcus, enterococci and staphylococci were the most common organisms obtained from the patients with bacteriuria. A group of 50 normal men served as controls.

Asymptomatic bacteriuria may be present in a normal, active person without his knowledge and without the production of symptoms. The presence of an indwelling urethral catheter is always accompanied with bacteriuria by the end of seventy-two hours, and patients who are treated with tidal drainage have an alkaline urine, which cannot be acidified. Uncomplicated bacteriuria may be distinguished from infection of the urinary tract by the mode of onset of the latter, particularly when there is a sudden rise of body temperature, which is usually accompanied with a chill. Also, observations on the clinical course and study of the patient's urine are of diagnostic value.

The authors state that "sterilization of the urine in the presence of an indwelling catheter used as part of the tidal-drainage apparatus in treating patients with cord injuries has been impossible except by withdrawal of the catheter, and is unnecessary provided that the latest type apparatus is used and is properly adjusted to the bladder it is serving." Patients with injuries of the spinal cord who have infections of the urinary tract are best treated by properly adjusted tidal drainage, rest in bed and the administration of large amounts of fluid, preferably by mouth.

Patients who recover from an injury of the spinal cord may have a normal genitourinary tract with normal function, without bacteriuria, unless they have had a transection of the spinal cord, a urinary calculus, a draining periurethral abscess or a lesion that has produced permanent physiologic or anatomic denervation of the bladder. The patient with transection of the spinal cord may expect a reflex bladder without bacteriuria. In ordinary circumstances there is no need for an indwelling catheter in this type of situation. However, if there is denervation of the bladder as the result of injury, the bladder will be shrunken and useless, with subsequent bacteriuria and probably recurrent bouts of pyelitis.

GUTTMAN, Philadelphia.

PAIN AND DISABILITY OF SHOULDER AND ARM DUE TO HERNIATION OF THE NUCLEUS PULPOSUS OF CERVICAL INTERVERTEBRAL DISKS. JOST J. MICHELSEN and WILLIAM J. MIXTER, New England J. Med. **231**:279 (Aug. 24) 1944.

Michelsen and Mixter report their observations on 8 patients who at the time of operation had a herniated nucleus pulposus in the lower cervical region. There was a lesion at the fifth cervical interspace in 4 patients, at the sixth interspace in 3 patients and at the seventh in 1 patient, with involvement of the sixth, seventh and eighth cervical roots, respectively.

The symptoms and signs were characterized by root pain and local sensory and motor disturbances, as well as by positive evidence in roentgenograms and on examination of the cerebrospinal fluid and injection of poppyseed oil. The distribution of sensory abnormalities was compared with standard dermatome charts. The sensory changes did not coincide precisely with those described in textbooks.

The authors stress the importance of systematic neurologic examination of patients with pain or disability of the shoulder and arm in order to separate the apparently specific syndrome of cervical herniations of the nucleus pulposus from other entities due to extraspinal and from intraspinal lesions.

Various so-called conservative methods of management had been tried for each patient, without permanent relief, prior to admission. The laminectomy and removal of the fragment of disk produced good results in 6 patients. In 1 patient the improvement was not impressive, while in another patient, 1 of the earlier ones, in whom the fragment of disk could not be removed for technical reasons, the pain was relieved but the motor disability persisted. More recently the authors have performed subtotal hemilaminectomies, with good results.

GUTTMAN, Philadelphia.

### Encephalography, Ventriculography, Roentgenography

THE ROLE OF X-RAY IN THE STUDY OF LOCAL ATROPHIC LESIONS OF THE BRAIN.

ARTHUR E. CHILDE and WILDER PENFIELD, *Am. J. Psychiat.* **101**:30 (July) 1944.

Childe and Penfield reviewed the results of roentgenographic studies in 142 cases of focal epilepsy not due to expanding lesions. The material included plain roentgenograms, cerebral pneumograms and cerebral arteriograms. The authors found that unilateral atrophic lesions occurring early in life frequently produce cranial asymmetry, which can be detected in plain roentgenograms. In cases of post-traumatic epilepsy frequently plain roentgenograms reveal no localizing information, but tears in the dura may result in destruction of bone through pressure of the brain and new bone formation. Whenever focal cerebral atrophy is suspected, air encephalographic studies should be undertaken. It is rare for an encephalogram to fail to demonstrate the location of the atrophic lesion. Usually the exact site of a focal epileptic lesion cannot be demonstrated by air encephalography alone, and careful correlation of clinical, electroencephalographic and roentgenographic evidence is essential. Occasionally cerebral arteriography is of value, especially when aneurysm or hemangioma is suspected.

FORSTER, Philadelphia.

ROENTGEN ANALYSIS OF UPPER CERVICAL SPINE INJURIES. WALTER N. PALMQUIST, *Radiology* **40**:49 (Jan.) 1943.

Palmquist describes a method for the precise interpretation of the roentgenograms of the upper cervical portion of the spine with the aid of index lines for guidance. The first requisite of the method is a clear, accurate lateral exposure made with the patient in the erect posture. For accurate analysis of the roentgenogram of the cervical region which does not demonstrate an obvious gross abnormality, at least six guide lines must be drawn. In the presence of serious injury of the upper cervical region it may be possible to use only five lines. Four lines will suffice when there is no injury of the upper cervical region and when normal hyperextension exists.

The lines are drawn in the following manner: 1. The first line is drawn in a horizontal plane passing medially through the body of the atlas and is designated as *a*. 2. Three parallel lines are then drawn perpendicular to *a*, passing, respectively, through the point where *a* intersects the anterior surface of the upper odontoid process (line *c*), the point where *a* intersects the anterior surface of the tubercle of the atlas (line *at*) and the point where *a* intersects the mandible (line

*am*). 3. A fifth line *b* is drawn along the anterior edge of the body of the axis. 4. A sixth line, *ab*, is drawn parallel to the vertical line *c* but passes through the lower anterior corner of the body of the axis. The three guide lines parallel to the vertical line *c* determine three spaces, namely, *d*, *e* and *j*.

It must be remembered that these lines are of significance only when the roentgenogram has been made with the subject in the erect position. With the head in hyperextension their value is seriously impaired. Spaces *d* and *e* are not appreciably affected by flexion or extension of the head.

In the normal view the spaces *d* and *e* are equal, so that their ratio is 1:1. The line *c* will show the tubercle of the atlas to the left. Test line *a* will be at right angles to test line *b*, which, in turn, will coincide with test line *c*, as does also the test line *ab*.

Variations from the normal will readily demonstrate abnormalities not apparent on the roentgenograms unless the procedure outlined has been carried out.

KENNEDY, U. S. N. R.

## Society Transactions

### CHICAGO NEUROLOGICAL SOCIETY

A. J. Arieff, M.D., in the Chair

Regular Meeting, March 13, 1945

#### Progressive Hemiplegia: Report of a Case. DR. JOSEPH P. REICH.

A man aged 60 noticed weakness in his left arm, which developed into almost complete hemiplegia within about four weeks. Approximately two weeks later, after an attack of headache on the right side and convulsions involving his left arm, complete paralysis of the left leg and paralysis of the left lower portion of the face were found. Eleven days later death occurred with the signs of acute respiratory paralysis. During almost the whole course of the disease jacksonian attacks occurred several times a day, beginning in the left hand, at times limited to it and at other times spreading over the whole left side or even over both sides, with frequent deviations of the head and eyes to the left. There was no loss of consciousness. Slight haziness of the nasal borders of both disks was present but was not progressive. The blood pressure and urine were normal. The spinal fluid was normal; the pressure was not increased. An air encephalogram, made two or three weeks after the onset of the first symptoms, showed nothing abnormal. The anatomic diagnosis was tumor (glioblastoma multiforme) occurring principally in the white substance of the right hemisphere and extending into the adjacent precentral and postcentral gyri. The anterior horn of the right lateral ventricle was compressed and slitlike.

The picture of "progressive hemiplegia" was first described by Oppenheim (*Internat. Clin.* 4:177, 1899) and later by other authors. The two pathologic changes most frequently associated with this condition were softening and tumor of the brain. Mills and Spiller (*J. Nerv. & Ment. Dis.* 30:385, 1900) reported a few cases, in which they noted slowly progressive degeneration of the pyramidal tracts.

In the present case the diagnosis of tumor was made despite the absence of specific symptoms and of encephalographic evidence. This diagnosis was based mainly on the frequent jacksonian attacks, which are rare with vascular lesions.

#### DISCUSSION

DR. PAUL C. BUCY: Dr. Reich has presented an interesting and instructive case. It is worth reporting, particularly because it illustrates some of the neurologic and diagnostic problems which have confronted neurologists so often in recent years. A few years ago one saw most patients with cerebral tumor when the diagnosis was not difficult. Today, however, patients come when the symptoms and signs are slight. Therefore the neurologist has come to rely more and more on mechanical means of diagnosis, particularly on ventriculography and encephalography. It is well, therefore, to realize that these methods are by no means free from error. It is possible to have a tumor with an apparently normal subarachnoid space and ventricular system as demonstrated in the pneumoencephalogram, a situation I have encountered in several cases not unlike the one reported by Dr. Reich.

DR. GEORGE B. HASSIN: In his discussion of the differential diagnosis, Dr. Reich mentioned the progressive hemiplegia of Mills, which is a chronic disease process requiring years for its development, whereas the progressive hemiplegia in Dr. Reich's case developed within a relatively short period. I think the caption in Dr. Reich's case should be "acute or subacute progressive hemiplegia." In

Mills's form the facial nerve is not involved; the paralysis is ascending, although it may also be descending, and the disease is evidently a form of amyotrophic lateral sclerosis. Acute progressive hemiplegia may be due to vascular syphilis, instances of which I have reported (*Clin. Rev.* 20:404, 1904; *Med. Fortnightly* 23:205, 1907). In such cases the process readily yields to antisyphilitic treatment.

### **Surgical Repair of Defects of the Skull: Analysis of 120 Cases. CAPT.**

I. JOSHUA SPEIGEL, Medical Corps, Army of the United States.

I. From an analysis of 113 cases of compound fracture of the skull initially treated overseas, with resultant defects of the skull, the following conclusions are reached:

1. Adequate débridement performed as soon after the injury as possible, with closure of the wound in anatomic layers without drainage, is a highly dependable form of therapy for compound fractures of the skull.
2. Free fascial transplants for dural defects, although in general useful, can be responsible for the maintenance of infection in a wound and should be used with that possibility in mind in any case of a potentially infected wound.
3. The most frequent site of injury is the parietal region.
4. The average size of the defect in the skull in this series was 5 cm.
5. The neurologic sequelae frequently vary directly with the period of unconsciousness.
6. The development of the "post-traumatic syndrome" of headache, dizziness and vomiting is inversely related to the severity of the injury.

II. The following technics in the repair of defects of the skull with tantalum have been tried and found useful:

1. With screws
2. With wires
  - (a) Through full thickness of the skull
  - (b) Through partial thickness of the skull
3. With glazier's points
  - (a) Without countersinking of the plate
    - (1) Points through the plate
    - (2) Points over the plate
  - (b) With countersinking of the plate
4. With countersinking and "springing" of the plate into the defect

III. The following technics in the preparation of tantalum plates have been tried and found useful:

1. Hammering the plate over a concave and convex block
2. Bending the plate with curved dental forceps after slits are cut in the periphery of the plate
3. Accurate reproduction of the normal contours of the head with a die and counterdie.

The last method is best if proper equipment and personnel are available.

IV. From an analysis of postoperative results in 120 cases of repair with insertion of a tantalum plate the following conclusions are reached:

1. Serosanguineous fluid frequently forms over tantalum plates for a few days after the operation. Aspiration of the fluid is without danger. Its development can frequently be precluded by having numerous perforations in the plate and draining the operative wound for a few hours after operation.

2. Any scars less than 3 mm. thick and over 1 cm. square which will lie over the tantalum plate should be resected, or they will break down.
3. A musculocutaneous scalp flap is generally the best method of exposure, although frequently it is advisable to go through the old scar.
4. If relaxing incisions must be made, they should not be in areas directly overlying the tantalum plate, as these areas will not fill in.
5. In rare cases the tantalum will cause continual drainage of serosanguineous fluid and should be removed.
6. After a period of four and a half months the plate is covered with a fine, smooth membrane, which is not adherent to anatomic structures or to scar.
7. When infection exists, much time can be saved by excision of the infected area and closure (with relaxing incisions if necessary), followed in a few days by insertion of the plate. Although the tantalum is a foreign body, its presence does not particularly encourage the onset of postoperative infection.
8. Convulsive seizures can generally be precluded by the prophylactic administration of phenobarbital.
9. In roughly 50 per cent of cases with minor neurologic sequelae, especially the "post-traumatic syndrome," the condition is greatly improved after insertion of a tantalum plate.
10. In small series of cases "improvement" appeared in the electroencephalographic tracing after repair of the defect.
11. In cold weather the tantalum plate becomes cold, with resultant slight discomfort.
12. It is recommended that tantalum be available, in sterile condition, in all neurosurgical operations in which, for one reason or another, the sacrifice of a portion of the skull may become a necessity.

## DISCUSSION

DR. A. EARL WALKER: Dr. Spiegel has presented an interesting paper which gives neurosurgeons many valuable hints on cranioplasty. During and after each of the great wars there has always been an awakened interest in the repair of defects of the skull. Many substances have been used for cranioplasty at various times. In World War I an alloplastic material, pyroxylin, was favored. In this war tantalum is widely employed. One is struck by the fact that when tantalum is used for the repair of a large defect roentgenograms of the skull reveal little of the details beneath the plate. In cases of such defects, which are usually associated with trauma to the brain and in about 40 per cent of which convulsive seizures develop, it seems desirable to be able to determine pneumoencephalographically the amount of distortion of the brain tissue. In order to obviate this disadvantage of tantalum, methacrylate plates may be used. These plates are not radiopaque, can readily be made in any shape and do not appear to produce any more tissue reaction than does tantalum. For the larger cranial defects and those associated with damage to the brain, the use of a radiolucent plate has definite advantages. For small defects probably tantalum is the best available substance.

DR. VICTOR E. GONDA: I understand that if tantalum stays in the body for longer than one or two years it becomes very fragile. I should like to ask whether by putting holes in the plate there is any danger of the plate fracturing even more easily.

CAPT. I. JOSHUA SPEIGEL, Medical Corps, Army of the United States: I agree with Dr. Walker that the presence of a large tantalum plate is a hindrance to accurate pneumoencephalographic study. On the other hand, it is my impression that there will be fewer cases in which a convulsive disorder develops than there have in the past because of the more careful front line surgery, with accurate débridement and dural repair, which is now available to the wounded soldier. I agree, also, that a translucent material would be more desirable. I have had no

experience with methacrylate plates, but Major Elkins, in another neurosurgical center, is using this material a great deal. His results are apparently fully as good as are those with the use of tantalum. I might mention, also, that in all our cases in which there is evidence of injury to the brain encephalographic and pneumoencephalographic studies are made before the plate is inserted.

In answer to Dr. Gonda, I cannot deny that putting holes in the tantalum plate weakens it somewhat, but I have never heard of a tantalum plate breaking, although I can conceive of its buckling if struck directly. The statement that tantalum becomes fragile when it stays in the body for one or two years is news to me. It is hard to believe that a substance as inert as tantalum can be changed by remaining in the body.

#### **Psychophysilogic Interrelationships. DR. MEYER SOLOMON.**

The term "psychophysilogic" seems preferable to "psychosomatic."

The terms "mentation" and "psychologic," "subjective" or "mental" activity seem preferable to "mind" or "psyche."

The activities within the psychophysilogic organism, or body, are divided into psychologic and physiologic, both of which are bodily, or organismal activities. The physiologic bodily activities are divided into skeletal motor and skeletal sensory, visceral motor and visceral sensory and physicochemical (including hormonal).

The interrelationship between psychologic and physiologic functions may be (a) immediate (skeletal and visceral activities during running or fear), (b) remote (loss of weight from worry, insomnia or poor appetite), (c) direct, or primary, without any intermediate link (raising the arm under command) and (d) indirect, or secondary (suppurative, cardiovascular and other changes in simultaneous or antecedent, vigorous movements of the extremities and trunk).

Emotional activity is a combined psychophysilogic excitement, involving all levels and differing from vigorous voluntary activity in its psychologic state.

Such psychologic activity as ideation, wishing and willing occurs in normal wakefulness, partial wakefulness of dreaming, simulation, hypnosis, hysteria and other psychoneuroses and psychoses.

This discussion is concerned mainly with how psychologic can influence physiologic activity—how ideation (including wishing and willing) can influence skeletal motor, skeletal sensory, visceral motor, visceral sensory and physicochemical functions.

The remote influence of psychologic on physiologic states is practically unlimited, through such factors as unhygienic habits, insomnia, anorexia and loss of weight.

The immediate influence of the psychologic on each physiologic level was discussed separately.

##### **1. On the skeletal motor system**

- (a) Ideas can immediately and directly lead to transient excitement and modification or suspension of function of the skeletal motor system.
- (b) Ideas cannot lead immediately and directly to such disorders of a prolonged nature.
- (c) Deep and superficial reflexes can be inhibited or exaggerated by skeletal muscular contraction.

##### **2. On the skeletal sensory system**

- (a) Ideas cannot evoke, directly, transient or permanent sensory phenomena.
- (b) Pain seems always to be of peripheral origin, centrally appreciated.
- (c) Concentration of attention makes one more aware of normal or abnormal sensation from any area.
- (d) Distraction of attention inhibits the degree of awareness of sensations.
- (e) Ideas cannot produce continuous sensory loss.

## 3. On the visceral motor system

1. Ideas can influence visceral muscles immediately and transiently, but only indirectly, the visceral manifestations being supportive, and secondary to or concurrent with primary activity of the skeletal motor system, as in voluntary activity or emotional response.
2. There is an inhibiting or enhancing influence, directly and temporarily, on such partially voluntary activities as the functions of the urinary genital and respiratory systems and both ends of the digestive system.
3. So-called voluntary control of the heart beat and the pupil seems no exception but is affected immediately, indirectly and transiently by momentary assumption of attitudes of tension, anxiety, expectation and fear.
4. Even indirectly, ideas cannot produce permanent, prolonged or continuous changes in the visceral motor system.
5. Ideation or suggestion cannot directly produce disorders of a vasomotor, secretory or trophic nature. Conditioned salivary and gastric responses are but part of a total response of an excited organism.

## 4. On the visceral sensory system

The same principles hold true for the visceral as for the skeletal sensory system.

## 5. On the physicochemical, including the hormonal, system

These functions are not influenced directly, transiently or permanently by ideation but are part of emotional or voluntary activity.

In general, ideas can lead immediately, but only indirectly, to transient functioning of the vegetative and physicochemical levels, by first producing activity of the skeletal motor system, which is accompanied with simultaneous adaptive changes in the vegetative and physicochemical systems, or by first exciting emotional response which involves all levels, including the skeletal.

## DISCUSSION

DR. CHESTER DARROW: Dr. Solomon has raised many controversial questions. Owing to the lateness of the hour, I may discuss only a few.

Like Dr. Solomon, I, too, feel more comfortable with the term "psychophysiologic" than with the term "psychosomatic," but I can find little quarrel with those who like the latter term. It is not something new. The term "psychosomatic" and a discussion of the problems implied were recently called to my attention in a Mid-Victorian novel, "Hard Cash," written by Charles Reade in 1868.

One may question Dr. Solomon's definition of the field of psychology as the study of "subjective and conscious processes." There surely would be a protest from psychologists should one thus "fence it in." Psychology is concerned not merely with the conscious and the subjective but also with those adaptive functions of the nervous system which permit modification of behavior by experience. This is true of the skeletal system, and secondarily also of the autonomic system. Such learning and retentive functions are not necessarily either subjective or conscious, but they are functions of the mind. I suspect that it is by means of learned sequences of response—neuronal, skeletal and autonomic—that many psychophysiologic effects are accounted for.

I heartily approve Dr. Solomon's differentiations of psychophysiologic relationships into immediate and remote; direct, or primary, and indirect, or secondary. Recognition of such differences may prevent much loose thinking. It should, however, be emphasized, and Dr. Solomon will doubtless assent, that directness is largely a matter of degree. Most psychophysiologic effects, as he himself emphasizes in the case of posturally induced autonomic changes, are indirect. It may be questioned whether even postural events are not likewise secondarily induced, if one carries the analysis far enough.

Indeed, it is present day recognition of the indirectness of control, together with recent advances in knowledge of neurology, humoral transmission, glandular secretion, function of moderator nerves and metabolic processes, that has contributed as much as anything to the discarding from psychiatry of symbolic magic and to the abolishment of witch doctor technics. It has permitted the tracing of neurophysiologic dynamic mechanisms, which formerly were a sealed mystery. Sequences by which spastic colon, gastric ulcer or hypertension may derive from ideas or attitudes become clearer, and better methods of control are acquired.

An indirect mechanism which my associates and I sometimes see in our own laboratory is that of fits or seizures which are suspected of having a hysterical basis but which on examination appear to be precipitated either deliberately, by voluntary hyperventilation, or unintentionally, as a result of emotionally induced hyperventilation.

Certainly, I should agree that emotion may begin in the brain. A man's blood pressure can be shown to rise at the sound of a certain word. In his extra-curricular education he presumably learned the meaning of that word, and his present recognition of the meaning implies cerebral activity. I do not, however, accept the statement that reverberations from the periphery or from the basal ganglia never initiate, or even augment, emotion. On the contrary, psychologic and psychiatric observation and physiologic experiment support the view that they may. How often is there indication to the psychiatrist of an unfixed, generalized, "free-floating" anxiety, tension, hostility or depression, existing, as it were, in supersaturation and ready to crystallize about the first psychologically sufficient impurity in the preceptual field! In such cases the emotion seems to lurk in the physiologic mechanism, while the brain merely provides an acceptable direction for its escape or, in some cases, merely rationalizes the event post facto.

As to the statement that ideas do not modify preception: I think the experimental work cited by Dr. Wallenberg at a recent meeting of this society should go far toward refuting such a view. The question appears to me particularly important at the moment because of indications from studies by my associates and myself that autonomic function and emotion may modify the electroencephalogram. Such evidence for neurophysiologic "feed-back" to the brain during ideation and emotion seems to offer one more neurophysiologic mechanism to account for psychophysiologic effects of the type which Dr. Solomon has discussed.

DR. MEYER SOLOMON: I appreciate Dr. Darrow's fine discussion. There is considerable difficulty in the use of terms, which are often not clearly defined. I have tried, perhaps unsuccessfully, to define in what sense I have used the various terms. The sequence of events is important. I did not mean to be dogmatic; rather I wished to point out some problems for research in the field of psychophysiologic interrelations. One must carefully differentiate between mentation, or psychologic activity, and emotional activity, which is psychophysiologic. It seems to me that the whole field of psychophysiologic, or so-called psychosomatic, interrelationships needs careful, critical review, with emphasis on relationships or influences which are immediate or remote, direct or indirect.

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NEW YORK NEUROLOGICAL SOCIETY AND NEW YORK ACADEMY OF  
MEDICINE, SECTION OF NEUROLOGY AND PSYCHIATRY

*Combined Meeting, March 13, 1945*

Byron Stookey, M.D., *President, New York Neurological Society, in the Chair*

**Ménière's Syndrome: Comparison of the Results of Medical and Surgical Treatment. DR. MILES ATKINSON.**

This paper was published in full in the September 1945 issue of the ARCHIVES, page 192.

## DISCUSSION

DR. BRONSON SANDS RAY: Dr. Atkinson has asked me to present results of the surgical treatment of Ménière's syndrome. Various surgical procedures have been, and are still, employed, but the one which I believe to be most useful and with which I have had experience is division of the eighth nerve intracranially. This operation has been employed by neurosurgeons for the past fifteen years. My conclusions are based on personal experience with 40 patients subjected to section of the eighth nerve during the last seven years. During this period I have seen a great many other patients who had more or less definite symptoms of Ménière's syndrome, and I have advised operation perhaps for as many patients as I have operated on. It is important to adhere to the three criteria necessary for diagnosis of Ménière's syndrome: paroxysmal vertigo, tinnitus, and progressive loss of hearing on the side of the tinnitus when the latter is unilateral.

An analysis of the cases has brought out some interesting points. The age incidence was between 20 and 70; 15 per cent of the total number of patients were in each of the third, sixth and seventh decades of life. In the fourth and fifth decades the incidence was higher, namely, 25 and 30 per cent, respectively. The distribution was about equal between the two sexes. In 25 per cent the first symptom to appear was an attack of vertigo; in 32 per cent, unilateral tinnitus, and in 30 per cent, impairment of hearing. In 4 per cent two or more of these symptoms occurred simultaneously in the beginning. In 6 patients the condition might be classified as bilateral, since there were tinnitus and impaired hearing on both sides, but in each patient the hearing defect and the degree of tinnitus were greater on one side. All patients had some impairment in hearing. Ninety-two per cent of the patients had lost 35 per cent or more of their hearing on one side; none was totally deaf on even one side. Caloric tests showed normal responses in 32 per cent, absence of vestibular response in 12 per cent, impairment of vestibular response in 36 per cent and an increase of the normal response in 20 per cent—all on the side of the tinnitus and loss of hearing when these were unilateral. Various combinations occurred in the patients with bilateral tinnitus and loss of hearing. Seventy-five per cent of the patients had been under some form of medical therapy, without sufficient benefit, prior to operation. Some of these patients had been treated by Dr. Atkinson medically, and he believed they had not responded adequately.

In 40 per cent of the patients a total division of the eighth nerve was performed; in 60 per cent, only a partial division, i. e., a section designed to interrupt the vestibular part of the nerve and to preserve as much as possible of the acoustic portion. There was 1 postoperative death, that of a patient with hypertension who died suddenly of a cerebral vascular accident. In 2 patients the attacks of vertigo were not abolished. In both these patients partial division of the nerve had been done, and caloric tests made postoperatively showed that some of the vestibular portion of the nerve remained functional in both. On 1 of these 2 patients a second operation was done, and total section of the nerve completely relieved the attacks. The other patient did not wish to have a second operation. Thus, with these 2 exceptions, every patient was relieved completely of attacks of vertigo.

The effect of the operation on tinnitus was somewhat variable. In general total section of the nerve was more advantageous, for 50 per cent of the patients having total section were completely relieved of tinnitus, whereas only 15 per cent of those with partial division had complete relief. In about one-half the patients there was some degree of unsteadiness for a matter of several weeks to months after operation. This was most noticeable to them on sudden change of position, but all eventually found that the symptom disappeared completely or became so slight that it was unimportant to them. Interestingly, a number of patients claimed that their everyday hearing was improved even when total section of the involved nerve was performed.

In the group with bilateral tinnitus and impaired hearing\*the results were gratifying. I was led to believe from others' experience that in cases of bilateral

Ménière's syndrome bilateral section of the nerve was sometimes necessary, but I have not found this to be true. Dr. Atkinson has suggested that the patient with one eighth nerve destroyed will not experience vertigo, since the occurrence of vertigo may somehow be dependent on the imbalance between two intact mechanisms. Of course, in the patients with bilateral impairment of hearing it is perhaps more important to perform a partial section of the nerve, in an attempt to preserve all the residual hearing that the patient has.

Except for transient postoperative weakness of the face in 2 cases, there were no untoward complications of the operation. In general it may be said that the operation is a satisfactory one, for if all the vestibular portion of the nerve is divided abolition of the paroxysms of vertigo can almost be guaranteed. In the majority of cases I have come, rather, to prefer total to partial section of the nerve. This attitude is due to the fact that only a few patients have much useful hearing in the involved ear at the time they come for operation, to the better chance of terminating the tinnitus with total division of the nerve and, finally, to the possibility that the attempted preservation of the acoustic portion of the nerve may result in incomplete section of all the vestibular fibers. It is true that the operation entails craniotomy and is potentially hazardous, but the complications should be few and the mortality low. Most patients are up and about in a few days and require about ten days' hospitalization. For selected patients I consider the operation eminently satisfactory.

DR. MILES ATKINSON: I agree with Dr. Ray that the patients must be carefully selected and that one may expect success in 100 per cent of such cases. Dr. Ray's point that bilateral nerve section is not necessary in cases of bilateral Ménière's disease is of great importance. I think, Dr. Ray, you said you had never had to do such an operation?

DR. BRONSON SANDS RAY: That is correct.

DR. MILES ATKINSON: I am quite sure it is a bad thing to do. It is never necessary in cases in which the diagnosis has been correctly made and should not be performed at all in cases in which the diagnosis is incorrect.

DR. LEON H. CORNWALL: Dr. Ray said that the mortality rate for these operations should be low, but he reported 1 death in his series of 40 cases. That is a mortality rate of 2.5 per cent. Does he regard that as low?

DR. BYRON STOOKEY: May I answer Dr. Cornwall's comment by saying that I consider it extremely low? The operation is a serious one, and a suboccipital decompression is done. I think Dr. Ray's results are excellent. In my opinion, total resection of the eighth nerve is far superior to a differential section.

DR. BRONSON SANDS RAY: The rate is a relative matter; 2.5 per cent is a comparatively low mortality rate, but though it might be lower in a larger series of cases one is never justified in disregarding the hazard of any operation.

**Relation of Nerve Impulse to Metabolic Processes.** DR. R. LORENTE DE NO (by invitation).

**Clinical Diagnosis of Disturbances of the Central Sympathetic System by Means of Pupillography.** DR. OTTO LOWENSTEIN.

As far back as 1908, Eppinger and Hess created the conception of sympatheticonia and vagotonia, by which, for the first time, a clinical approach to the diagnosis of diseases of the autonomic nervous system became possible. Subsequent clinical observations, however, showed that their conception was either not quite correct or incomplete. The work done subsequently by physiologists, particularly Langley, Sherrington, Starling, Gaskell, Bayliss, Elliott, Cannon and Bard, and by pharmacologists, particularly Hans Horst Meyer, Otto Loewi, H. H. Dale and their followers, created the basis for a better understanding of the clinical observations on the autonomous nervous system.

Nevertheless, one is still far from being able to examine the sympathetic nervous system clinically; in particular, the differential diagnosis of central and peripheral disturbances is frequently difficult or even impossible.

In order to show the importance of pupillography for this clinical purpose, I wish to start with a physiologic statement: The parasympathetic system discharges in the form of local reflexes; that means that only one outflow, or only a part of one outflow, is active at a time. The sympathetic system, however, tends to discharge *en masse*. For instance, when light is thrown into the eye, the only visible effect is contraction of the pupil; however, when I touch the eye, causing pain, there results not only dilation of the pupil but a total sympathetic discharge. The latter includes vasoconstriction of the blood vessels in the viscera and skin; elevation of the eyelid, and therefore widening of the palpebral fissure; acceleration of the heart rate, and increase in blood pressure. All organs provided for by the sympathetic nervous system are included; all effects are the immediate expression of the same stimulation, extending all over the body and controlled by the center.

In view of the discharge *en masse* and the radiation of sympathetic outflows over the body, every organ which is innervated by both the sympathetic and the parasympathetic system may become a test object for the mechanisms of autonomic control.

The pupil, especially, is suited to such analysis, for the following reasons: First, the iris is immediately visible; second, a great number of sympathetic and parasympathetic reflexes may be easily elicited in the pupils, and, third, the method of pupillography enables one to make an analysis of pupillary movements in every desirable degree of precision.

By recording the effects of stimulation of the hypothalamus, one could show that the posterior and lateral hypothalamic nuclei are chiefly concerned with sympathetic discharges, while the parasympathetic mechanism may be localized in the nuclei of the anterior portion and the midline, in the region of the tuber cinereum. Representation of pupillary activity, in both its sympathetic and its parasympathetic division, in the hypothalamus, where so many vegetative centers are distributed over a relatively small area, explains why analysis of pupillary function is so important. No extensive pathologic process, either irritative or destructive, is conceivable without participation of the pupillary hypothalamic pathways or centers, either as direct or as neighborhood signs.

The clinical syndromes concerned are diabetes insipidus, emaciation, adiposogenital dystrophy, hyperthermia, hypersomnia, epilepsy of autonomic origin and personality changes, particularly psychoneuroses.

It appears from pupillographic studies that some pathologic pupillary reactions are combined with some hypothalamic symptoms more frequently than with other hypothalamic symptoms. A certain number of pupillary reflexes are considered to be predominantly, although not exclusively, parasympathetic reflexes, such as the blinking reflex, the reflex to near vision and the reflex to light. Other reflexes are considered to be predominantly sympathetic reflexes, such as the reflex to darkness, the reflex to sensory and psychologic stimuli, the corneal and conjunctival reflexes and the psychosensory restitution phenomenon, of which I shall speak later.

All these reflexes undergo certain modifications characteristic of the site of the lesion. Absence or diminution of the psychosensory dilation phenomenon is characteristic of a lesion in the second or third sympathetic neuron, i. e., peripheral to the center of Budge; it is definitely located in the third neuron when cocaine no longer dilates the pupil while epinephrine dilates it.

When the pupil contracts to light and does not dilate again, one is concerned with a "sympathetic block," which may be partial or complete. The sympathetic block is a central inhibition phenomenon, indicating a disturbance in the central sympathetic system.

When the light reflex of the pupil is elicited again and again, fifty to one hundred times or more, at intervals of four seconds, the latent period becomes longer and longer; a refractory period develops, and the contraction becomes increasingly sluggish and inextensive. When the refractory period becomes longer

than the interval between application of the light stimuli, the pupil no longer reacts to light; i. e., it has become exhausted for the particular period of stimulation employed. When, nevertheless, stimulation of the pupil at the same interval is continued, with, however, a psychologic or sensory stimulus interposed between two light stimuli, the pupil, which up to then was exhausted, reacts again to the subsequent light stimulus (psychosensory restitution phenomenon, Lowenstein). Absence of the psychosensory restitution phenomenon points to a central lesion; exaggeration, to a central irritative condition.

The contraction to light consists of three phases—the primary, secondary and tertiary contraction phases. In a case of cyclic sympathetic paralysis (Lowenstein, O., and Levine, A. S.: Pupillographic Studies: V. Periodic Sympathetic Spasm and Relaxation and Role of Sympathetic Nervous System in Pupillary Innervation, *ARCH. OPHTH.* **31**:74 [Jan.] 1944) and cyclic oculomotor paralysis (Lowenstein, O., and Givner, I.: Cyclic Oculomotor Paralysis, *ARCH. OPHTH.* **28**:821 [Nov.] 1942) it could be shown by means of a well elaborated timing system that the primary contraction phase is predominantly due to parasympathetic factors, whereas the secondary and tertiary contraction phases are predominantly due to sympathetic factors. Absence or underdevelopment of the second contraction phase points to a lesion which is predominantly, if not exclusively, of the central sympathetic system.

Cases exist in which not only within the contraction phase of the pupillary reflex to light but in the redilation phase the parts conditioned by the central sympathetic system seem to be cut off; this leads to a type of reaction which I described, in collaboration with Westphal, for the first time in 1933 and which was named tonohaptic reaction.

Finally, I wish to mention two other types of reaction to light which are due to central sympathetic conditions: 1. The so-called climbing pupil. This type is characterized by the fact that the redilation is more extensive than the preceding contraction, causing the pupil to become larger after subsequent stimulations with light. 2. The so-called cogwheel reaction, in which both contraction and dilation occur in steps. These steps are due to sympathetic inhibitory influences.

A certain affinity exists between the various types of pupillary symptoms described and the various clinical diencephalic syndromes, particularly those of the hypothalamus; some pupillary symptoms are always combined with clinical symptoms, while others are frequently combined. A certain group of pupillary symptoms of undoubtedly sympathetic origin seems to occur independently; that is, they are not combined with other symptoms of known hypothalamic origin but are linked with psychologic symptoms and occur under the guise of a psychoneurosis. Sometimes they may precede the occurrence of clinical symptoms. In cases of postencephalitic hypersomnia, for instance, we observed the tonohaptic type almost exclusively, and the same is true of catatonia; in cases of hyperthermia we observed exclusively the climbing pupil, and in a certain group of cases of hyperthyroidism, those in which exophthalmos was a complication, we observed almost exclusively the sympathetic block. Absence of the psychosensory restitution phenomenon combined with the tonohaptic reaction occurs exclusively with chronic conditions. Those pupillary phenomena which are always linked with certain other clinical hypothalamic symptoms are likely to be due to the direct involvement of pupillary centers or pathways in the same pathologic process; those phenomena which are frequently linked with them probably must be considered as neighborhood symptoms. In more than 80 per cent of cases psychoneurotic symptoms are combined with central sympathetic (or parasympathetic) pupillary phenomena; here, too, it appears that certain psychologic unities are always and exclusively combined with certain pupillographic types.

#### DISCUSSION

DR. ISADORE GIVNER: Dr. Lowenstein has asked me to comment on the importance of pupillography in ophthalmology. I have had the opportunity of working with him on three problems; first, glaucoma; second, retinal angiospasm, and, third, the exophthalmos of hyperthyroidism. With regard to glaucoma: For

a long time we have felt that a central factor is involved in the control of intra-ocular tension. Dr. Lowenstein has been able to show for the first time that in patients with chronic simple glaucoma there is a disturbed pupillographic pattern in the unaffected eye, indicating that these persons have the conditions for the development of glaucoma in the opposite eye as well. With regard to retinal angiospasm: We studied several cases in which there was a central sympathetic factor. Also, we have studied 22 cases of exophthalmic goiter with the pupillographic method. In 21 of the 22 cases there was a definite pattern, which, as Dr. Lowenstein interprets it, was a central sympathetic pattern.

Pupillograms are made at a speed of 100 pictures per second. A normal tracing shows a latent period followed by a contraction and a latent period followed by redilation. In cases of hyperthyroidism there is a redilation block. So constant has been this observation that it occurred to me that the pattern might be of value in doubtful cases with unilateral exophthalmos. I should like to show kodachromes in 2 cases.

CASE 1.—In a case of unilateral exophthalmos, a roentgenogram of the skull made elsewhere was reported to show nothing abnormal. The pupillographic tracings were normal. In order to check on the roentgenographic studies in this case, a stereoscopic roentgenogram was taken; it showed a meningioma of the sphenoid ridge.

CASE 2.—A nurse with unilateral exophthalmos had a basal metabolic rate of +4 per cent. With a 100 mm. base line, the exophthalmometric measurements were 20 mm. for the right eye and 18 mm. for the left eye. The palpebral aperture was wider on the right side. The pupillographic tracings showed a typical redilation block. We felt, therefore, that her exophthalmos was based on dysfunction of the thyroid.

Dr. Lowenstein is to be congratulated on giving this additional laboratory aid in the diagnosis of disorders of the central sympathetic system.

DR. OTTO LOWENSTEIN: This paper was concerned with pupillographic features of lesions of the sympathetic system, either central or peripheral, and their differential diagnosis for clinical purposes. It was not concerned with lesions of the parasympathetic system. From pupillographic and clinical, as well as from purely clinical, evidence, sympathetic and parasympathetic disturbances appear to be interdependent, and only consideration of the whole picture enables one to make a diagnosis.

**Protest: A Recorded Psychiatric Program.** MAJOR ALBERT A. ROSNER, Medical Corps, Army of the United States.

A sound reel of a psychotherapeutic session with soldiers was presented.

## Book Reviews

**The Psychology of Seeing.** By Herman F. Brandt, Ph.D. Price, \$3.75. Pp. 240. New York: Philosophical Library, 1945.

This book is a compilation of studies done at the Visual Research Laboratories of Drake University, Des Moines, Iowa. The general areas of research are: "Instrumentation for Objective Observation"; "Basic Eye Movements"; "Advertising—Evaluated by Photography"; "Learning—Revealed by Ocular Performance"; "Art—Judged by the Response of the Observer"; "Ocular Patterns," and "Psychological Implications." These sections are preceded by an introductory chapter and are followed by a section on projected studies, a brief bibliography and a glossary. The general approach is toward the layman, on the assumption that he understands little about vision.

Among the new equipment described, there is a portable bidimensional camera which records every movement of the subject's eyes and the fixation of his eyes while reading. The author also reports a series of tests for determining the preferred positions in ocular movements. Through utilization of the method of ocular photography, several technics have been elaborated to determine the efficacy of various advertising devices. The author has investigated the attentivity of isolation and concludes that the use of white space for creating the state of isolation in an advertisement has not been fully appreciated and should be more regularly employed. With regard to color, the results show that red had no attentional advantage over black and white, except when utilized in headline form.

The author has been ingenious in applying the method of ocular photography to a variety of advertising problems, such as the determination of what relative amounts of time are devoted by men to the different parts of a woman's body, and likewise by women to the different parts of a man's body. The upper half of the man's body is dominant in attention-getting value, especially the face, collar and tie. For the woman, however, the foci of maximal attention are the hair, eyes and mouth. This was determined under the condition of asking the men to judge the age of a woman, whereas the women were asked simply to look at a man. The implications of this difference are obvious, especially in view of the absence of any emphasis on the woman's legs and feet.

Dr. Brandt has devised a series of designs in order to compare horizontal and vertical ocular movements and suggests that ocular photography will play an increasingly larger role in evaluating visual learning. On the basis of several experiments, the author makes some concrete teaching suggestions for improving instruction in algebra, arithmetic, spelling and geography.

Without entering into the nature-nurture controversy with regard to intelligence, Dr. Brandt contends that much about the intelligence of a person may be discovered by the study of his ocular performance. It is, of course, well known that perceptual acuity plays a great role in general intelligence and one's ability to learn, retain and reason. What seems more essential to the reviewer, however, is that motivational and emotional factors may influence perceptual acuity.

Toward the latter part of the book are discussed the applications of ocular photography (ophthalmography) to reading diagnosis, remedial therapy for reading difficulties, a study of how children read pictures and copy and the judgment of art as determined by ocular fixations.

After listing the essential determinants of attention and briefly discussing the problem of individual differences, Dr. Brandt closes the book with a consideration of some of the problems which have yet to be studied through ocular photography. Among these are certain unsolved problems in optometry, illumination and lie

detection; the general problem of efficiency; the relative importance of peripheral and foveal vision in relation to specific aptitudes for certain skills, and the importance of ocular movements as an additional evidence of alcoholic intoxication.

Dr. Brandt has succeeded in broadening the range of applicability of the technic of ocular photography from its originally narrowed use as a test in reading diagnosis. While there is less likelihood of any important theoretic discoveries emerging from the use of the technics developed, this book certainly illustrates the importance of evaluating ocular movements in a large variety of practical problems and is replete with many experimental suggestions.

**O tratamento cirurgico das doencas mentais.** By M. Almeida Amaral, M.D., with a preface by Egas Moniz. Price not given. Pp. xv, plus 149, with 18 illustrations. Lisbon, Portugal: Livraria Luso-Espanhola, 1945.

A further report on psychosurgery has long been awaited from Portugal, where this procedure was first developed. The present volume, however, is a distinct disappointment. It details only a dozen cases, in some of which the patient was followed for only a brief period, although recoveries of seven and eight years are described in the case reports. The arguments in relation to mechanism are presented in incomplete fashion, and a good deal of the book consists in a rehashing of observations and opinions already found in the literature. The bibliography is incomplete and contains numerous errors. The preface by Egas Moniz deals largely with the theories of Pavlov and their application to psychiatry, particularly as related to breaking up of the anatomic mechanisms underlying conditioned responses through prefrontal leukotomy. The author admits that, unfortunately, it has been impossible in Portugal to apply the operation on a large scale to sufferers from mental disorder. Of his 12 patients, 6 recovered, 3 improved, the condition of 2 was unchanged and 1 died.

**The Person in the Body.** By Leland E. Hinsie, M.D. Price, \$2.75. Pp. 264. New York: W. W. Norton & Company, Inc.

With the aid of much illustrative material from case histories, the author describes the forces which operate in the production of psychosomatic disturbances. He uses freudian principles and labels in identifying these forces and in tracing them to their origins. He does not, however, include the more labyrinthine interpretations but indicates, rather, that much change can often be effected by relatively simple psychotherapy.

The book is written for the physician who has had no special training in psychiatry and for the layman who might come to him for a psychosomatic complaint. In general, the book follows the growth of the person and points out the corresponding relationships of body and mind in the process and how often body and mind have to play "under-study" roles for one another. The mass of clinical data cited will carry conviction of the reality of the problem to the practitioner, who is likely to be the first to meet with cases of these disorders. There is a short chapter on the principles of psychotherapy.

The book is recommended.

**Aviation Neuro-Psychiatry.** By R. N. Ironside, M.B. (Aberd.), F.R.C.P. (Lond.), and I. R. C. Batchelor, M.B. (Edin.). Price, \$3. Pp. 168. Baltimore: The Williams and Wilkins Company, 1945.

The authors have written a practical guide to aviation neuropsychiatry. The studies are essentially descriptive, and no attempt is made to study the disorders dynamically, as has been done by other writers. Although the cases cited are based on wartime experiences, the authors are apparently oriented toward the needs of a peacetime aviation. Qualitative rather than quantitative considerations will guide the selection authorities of the future. With this in mind, the authors

stress the importance of a thorough psychiatric examination of prospective flying personnel. They minimize categorically the importance of special aptitude tests and also disagree with those who believe that the only test for combat is combat. In point, they state, "The temperamentally unstable in the affairs of everyday life are unlikely to become temperamentally stable by leaving the ground and becoming aviators."

With a thorough understanding of aviation physiology, the psychiatrist will be better able to evaluate hysterical and neurotic symptomatology. Aviation physiology is briefly but clearly discussed in this book.

There is certainly a justification for a book of this sort, but it can be used only as a guide, rather than as an exhaustive treatise on the subject. The authors make no claims which they do not clearly fulfil. The beginner in aviation psychiatry will do well to use this as an introductory guide.

**Hypnoanalysis.** By Lewis R. Wolberg, M.D., Price, \$4. Pp. 342. New York: Grune & Stratton, Inc., 1945.

In this book the author discusses hypnoanalysis, chiefly on the basis of material in the case of Johan R. He presents sufficient detail to make clear to the reader the facts from which are derived therapeutic technics and procedures used. In recent years one has witnessed the salutary appearance of books dealing with psychotherapy in which case reports are described. This makes it possible for the reader to evaluate the material and results in a much more definite manner. The patient, Johan R., chosen by Dr. Wolberg, has the capacity for expressing himself so well that it makes the reading of the case material of more interest than is usual in scientific reports.

There is recorded rather well the integrative use of hypnosis and analytic therapy. Apparently, it was possible by hypnoanalysis to make rapid strides in the treatment of a patient who was severely ill. At least in the case of this patient the procedure was a short cut to the desired end result. Without the use of hypnosis the analytic procedures either could not have been used or would have resulted in a much more prolonged therapy.

Numerous technics are used to facilitate the recapture of buried memories and to facilitate insight. The author uses hypnotic regression, hypnotic induction of dreams, hypnotic induction of phobias, hypnotic suggestions, automatic writing and the crystall ball induction of hallucinatory experience. These procedures and their role in therapy are ably described.

It is well to remember, as Dr. Wolberg points out, that the discovery of buried memories during hypnosis and their immediate use for therapy in the conscious state will often fail to be of benefit. Frequently the implications that these memories impart will not be accepted by the patient in the conscious state until he himself realizes their importance and presents the interpretation as a product of his own efforts and conviction. An effective technic to achieve this result is to instruct the patient under hypnosis to forget what he has learned until he is convinced of the truth of his memories and understands them thoroughly. Another technic is to revivify these memories by inducing the patient, under hypnosis, to see the recalled scenes in a crystal ball or mirror. This usually induces such profound emotional reactions that the patient's acceptance of them is greatly facilitated.

There is a good discussion of the relation of hypnosis and the transference situation, how the various resistances are to be manipulated and in what manner analytic interpretation is utilized in hypnoanalysis.

This book is a worth while contribution to the field of psychiatric therapy. It should be read by all workers in this field.

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JUNE 1946

PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH  
DEARBORN STREET, CHICAGO 10, ILLINOIS. ANNUAL SUBSCRIPTION, \$3.00

Entered as Second Class Matter Jan. 7, 1919, at the Postoffice at Chicago,  
Under the Act of Congress of March 3, 1879

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